Engineering News

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The Fifth Street Viaduct, Fitchburg, Mass.

There has recently been completed in Fitchburg, Mass., a reinforced-concrete viaduct on the line of Fifth St. across the valley which contains the Nashua River and the seven-track lines of the Boston & Maine, and the New York, New Haven & Hartford Railroads. The viaduct is remarkable in a number of respects, but mainly in that the reinforcement for the arch ribs proper was made of structural steel which was placed in its arch form between the piers and used to support the forms into which the concrete of the arch was poured. By this means no centering was required under any of the four small arches and only the lightest sort of strutting required under the large arch. In designing the structure the rises of the arches and depths of the arch rings were the requirements of clearance at the railway crossings were such that a deck arch could not be used, which fact, together with the requirements of design noted above, led to the adoption of the through arch shown on the drawings. It will be noted that the arches are of very low rise and are on high piers. Such a structure would not be stable under the unbalanced dead load of the arches on one side of the pier, but the construction was so carried out that each pier had a balanced load upon it at all times, and when the viaduct was completed its static condition is somewhat similar to a single arch. That is, the thrust is carried through from one abutment to the other through the various arches and their piers.

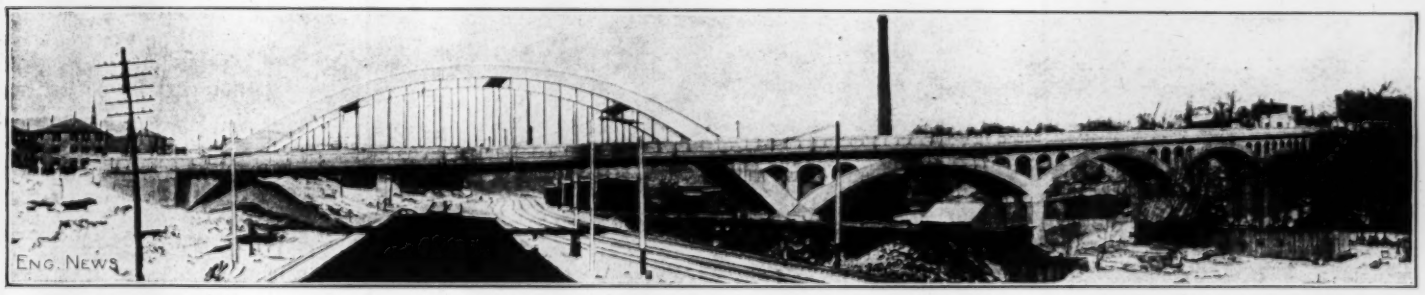


FIG. 1. THE FIFTH ST. VIADUCT, FITCHBURG, MASS.

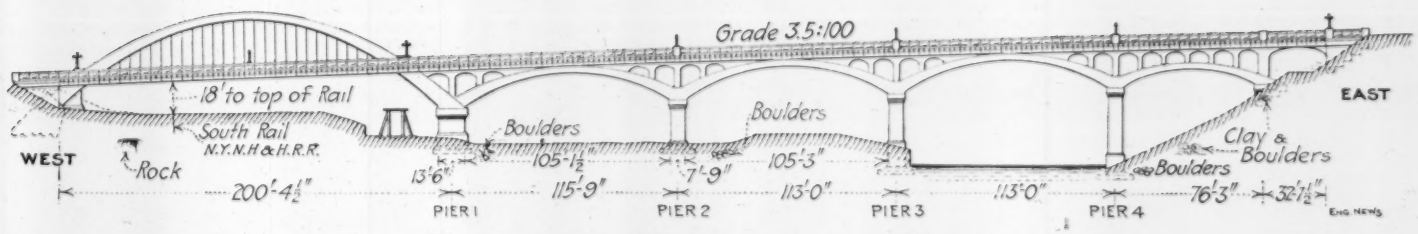


FIG. 2. OUTLINE ELEVATION OF THE VIADUCT

ABUTMENTS AND PIERS

The piers and abutments are all founded on rock or so proportioned as to make the steel needed for reinforcement for moving loads just about sufficient to carry the construction loads during erection.

The views above give an outline elevation of the structure. It will be noted that one side of the valley is considerably higher than the other, so that a grade of 3½% was required on the roadway. The bridge starting from the higher side of the valley comprises a small 32-ft. arch over a private road, a 76-ft. arch, three 113-ft. arches, and one 200-ft. arch across the railway tracks. All of these arch dimensions are from center to center of piers. The bridge is 40 ft. wide with a 26-ft. roadway, and two 7-ft. sidewalks, and is designed at present to carry only highway traffic, although interurban-car loadings are provided for.

All five of the smaller arches are deck structures, but heavy boulders, the rock rising nearer the surface at the west abutment, so that that abutment is founded on solid rock, whereas the east abutment is founded on a compact deposit of sandy clay. With the exception of the west abutment, all the piers and the east abutment are in quite shallow excavation, as the proper foundation was practically at the surface.

ABUTMENTS—The west abutment (Fig. 4) comprises two masses of concrete against which the two ribs of the large arch abut, together with two showing wing-walls, and a cross-wall to retain the earth fill. The abutment is of mass concrete with no reinforcement. The east abutment is in effect the pier between the 76-ft arch and the 32-ft. arch. This is similar in design to the west abutment, except that it has three masses of concrete to take the thrust from the three arch ribs which are used

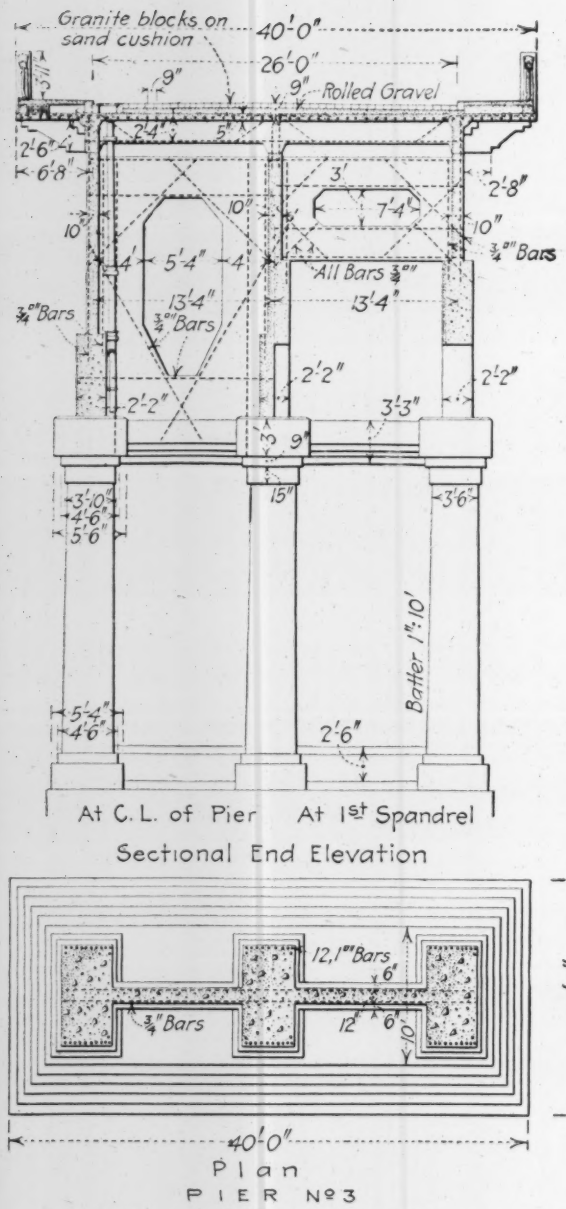
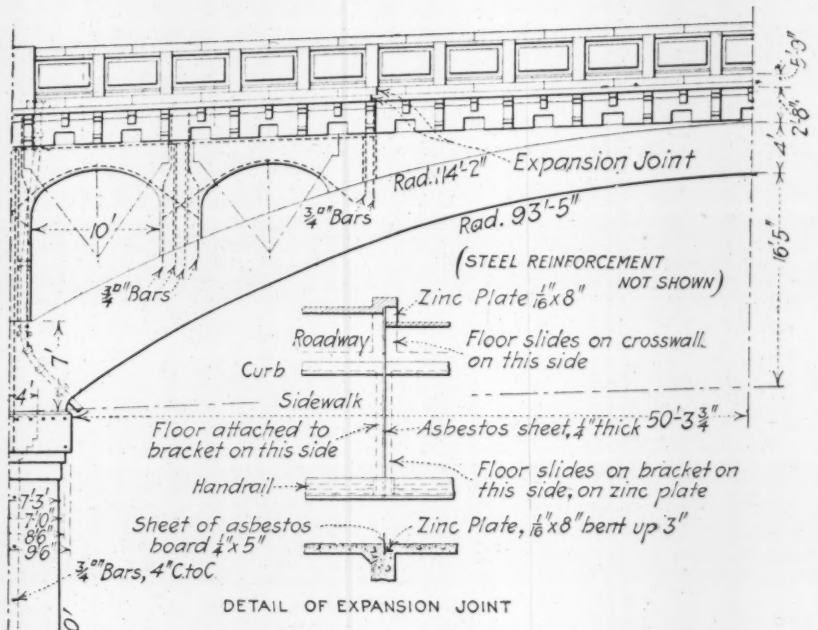


FIG. 3. TYPICAL PIER BETWEEN SMALL ARCHES AND DETAIL OF 113-FT. ARCH

(Rib reinforcement of 113-ft. arch not shown)


Expansion Joint
Rad. 114'-2"
Rad. 93'-5"
(STEEL REINFORCEMENT NOT SHOWN)
Zinc Plate 1/16 x 8"
Roadway
Floor slides on crosswall on this side
Curb
Sidewalk
Floor attached to bracket on this side
Asbestos sheet, ¼" thick
50'-3¾"
Handrail
Floor slides on bracket on this side, on zinc plate
Sheet of asbestos board ¼" x 5"
Zinc Plate, 1/16 x 8" bent up 3"
¾" Bars, 4" C to C

DETAIL OF EXPANSION JOINT

in the smaller arch mass. The true east abutment takes merely the thrust of the small 30-ft. arch and is provided with the customary wing-walls. These two eastern abutments are reinforced slightly.

PIERS—A typical pier design is shown in the design of pier No. 2 in Fig. 3. This pier consists of a base solid in plan and rising therefrom three columns under the respective arch ribs, joined together with a transverse wall 12 in. thick. These columns rise to the elevation of the bottom of the arch ribs, which come together over each column. It will be noted that the thrust from these opposing arches continues from one arch through into the opposite arch, and that if one arch were removed the thrust would fall far outside the section of the pier. These piers are slightly reinforced as shown.

ARCH RIBS

SMALL ARCHES—One of the 113-ft. arches is also shown on Fig. 3. It consists of three arch ribs placed 13 ft. 4 in. c. to c. and each 26 in. wide, 4 ft. deep at the crown, and about 7 ft. deep at the springing line. The chords of the arches are on the 3½% grade which the whole bridge has. These ribs carry the roadway on spandrel columns and arches, which are braced transversely by open walls, the upper portions of which form the floor-beams upon which the reinforced-concrete floor-slab rests. Each rib is reinforced with a steel frame similar to that shown in Fig. 5. This frame consists of a double girder made up of an upper and lower flange, each made up of angles with a center plate, joined together with vertical and slanting web angles. These ribs were fabricated in four sections and with splices at crown and haunches. In erection they were field-spliced together as a single arch, as described below. Each rib frames at the

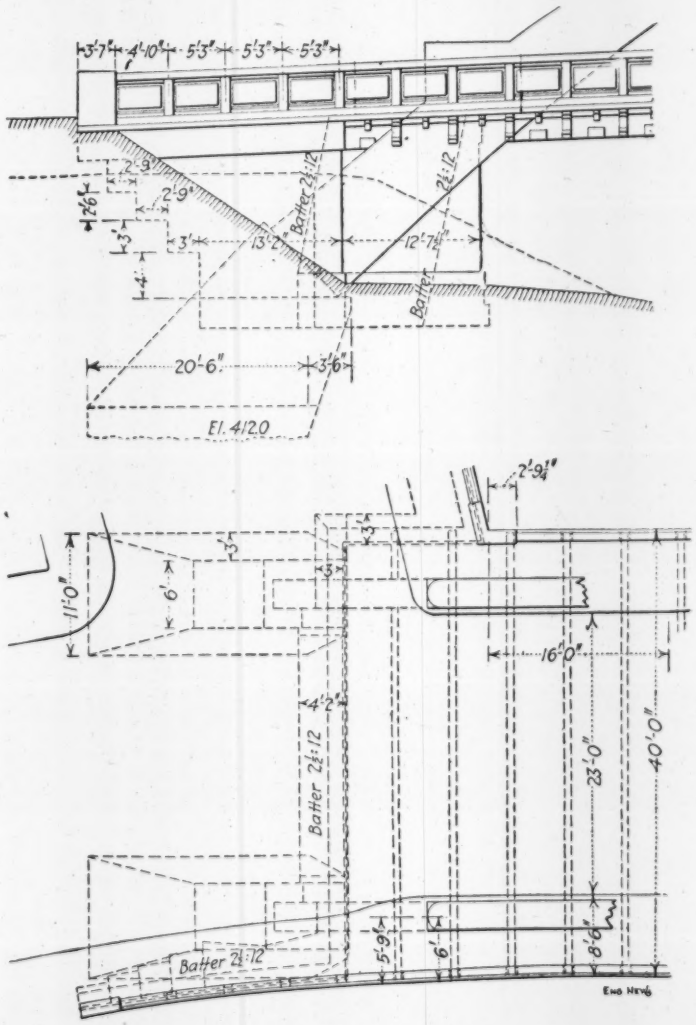


FIG. 4. DETAIL OF WEST ABUTMENT

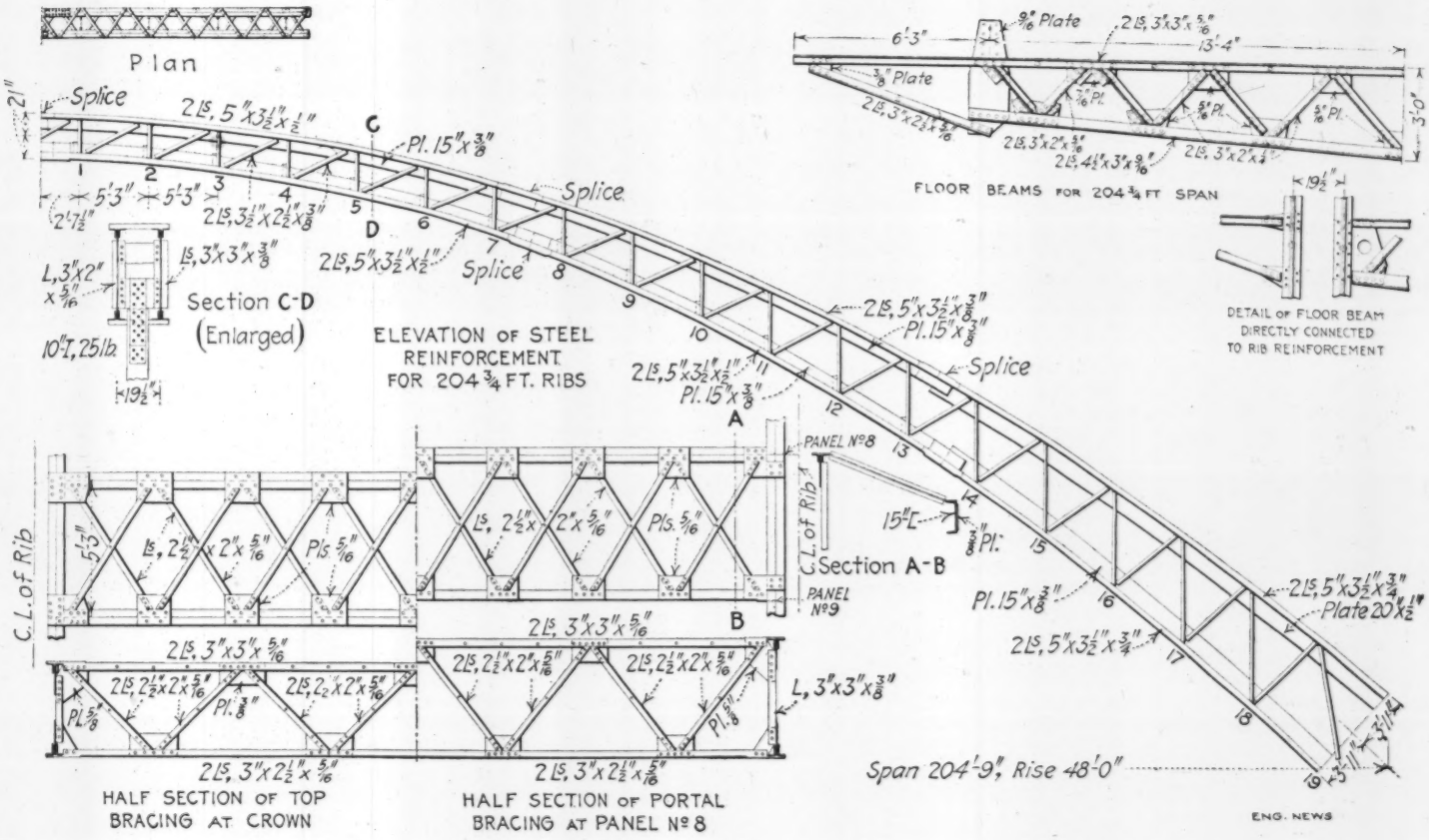

Plan
Splice
2 Ls, 5" x 3½" x ½"
Pl. 15" x ⅜"
Splice
Splice
2 Ls, 5" x 3½" x ⅜"
Pl. 15" x ⅜"
Splice
2 Ls, 5" x 3½" x ½"
Pl. 15" x ⅜"
Splice
2 Ls, 5" x 3½" x ⅜"
Plate 20" x ½"
Span 204'-9", Rise 48'-0"
Section C-D (Enlarged)
L, 3" x 2" x 5/16
Ls, 3" x 3" x ⅜"
10" I, 25 lb.
19½"
ELEVATION OF STEEL REINFORCEMENT FOR 204¾ FT. RIBS
⅜" Plate
2 Ls, 3" x 3" x 5/16
6'-3"
13'-4"
3'-0"
FLOOR BEAMS FOR 204¾ FT SPAN
DETAIL OF FLOOR BEAM DIRECTLY CONNECTED TO RIB REINFORCEMENT
PANEL No 8
PANEL No 9
C.L. of Rib
Section A-B
15" I
⅜" Pl.
2 Ls, 3" x 3" x 5/16
L, 3" x 3" x ⅜"
HALF SECTION OF TOP BRACING AT CROWN
HALF SECTION OF PORTAL BRACING AT PANEL No 8
ENG. NEWS

FIG. 5. DETAIL OF REINFORCEMENT FOR ARCH RIBS AND FLOOR BEAMS. (204-FT. ARCH.)

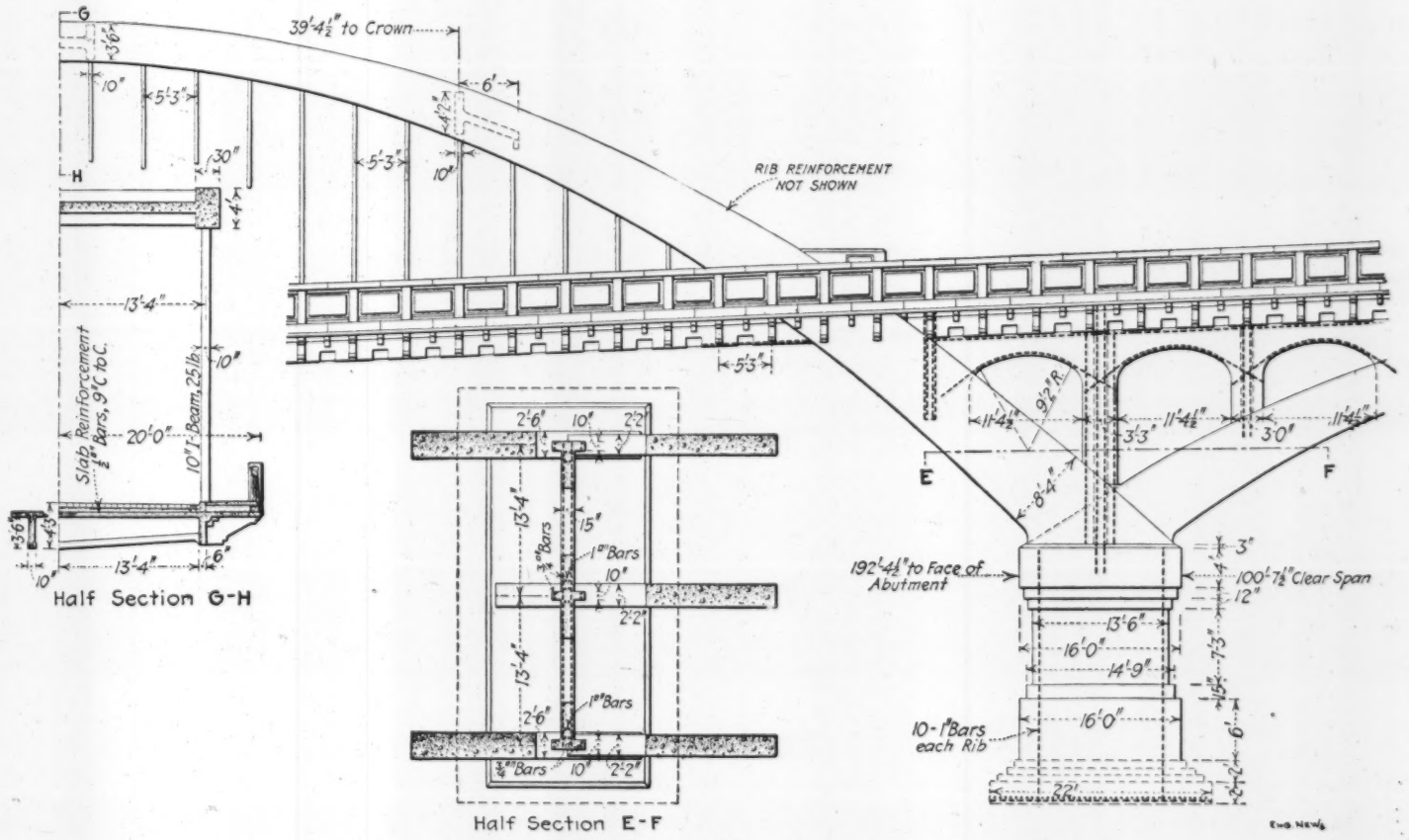


FIG. 6. DETAIL OF MAIN-ARCH SPAN

pier into a structural-steel pedestal, set on anchor bolts sunk into the pier. The detail of the pedestal between the smaller arches is shown in Fig. 7.

The spandrel columns, which rise out of the smaller arches, are of concrete reinforced with straight rods, which rods intrude into the concrete of the arch rib a short distance, forming the only connection between the spandrel columns and the ribs.

LARGE ARCH—Details of the large arch are shown in Fig. 6. The main carrying portion of this arch consists of two arch ribs 193 ft. 3 in. in the clear, with a rise of 48 ft. to the reinforcement arch, which has a center to center span of 204 ft. 9 in. Each rib is 4 ft. deep at the crown, 8 ft. 4 in. deep at the springing line, and 30 in. wide throughout. These ribs are practically on center with the two outside ribs of the adjacent small

arch (Fig. 6). The rib reinforcement is of structural-steel framework, shown in Fig. 5, which was fabricated in six pieces. The two ribs are braced together at the crown and haunches by cross-framing of structural steel incased in concrete. That portion of the roadway immediately over the pier is carried by spandrel arches as in the

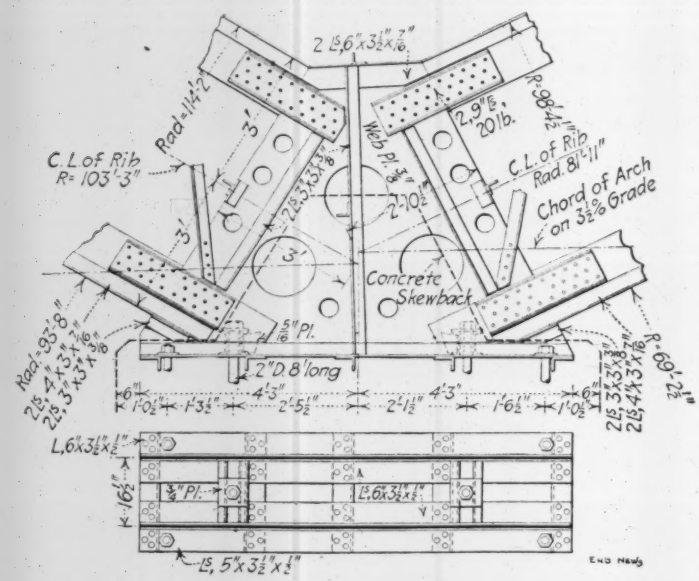


FIG. 7. STEEL PEDESTAL REINFORCEMENT ON PIER BETWEEN SMALL ARCHES

smaller span, but the main portion of the roadway is carried as a through structure from I-beam hangers framed between the two webs of the main reinforcement and carrying at their lower end the floor-beams, which are also of structural-steel framework incased in concrete.

FLOOR, RAILINGS AND EXPANSION JOINTS

That portion of the floor over the smaller arches is made up of a 5-in. reinforced-concrete slab paved with wood blocks, the whole resting on the concrete floor-beams noted above. In the hanging-floor structure under the large arch the floor-beams are reinforced with structural framework (Fig. 5), but carry the same type of floor as in the remainder of the structure. Expansion joints are provided at the haunches of each arch and above each pier. A highly ornamental railing cast in place is provided across the entire structure.

CONSTRUCTION

Work on the bridge started in October, 1911. The piers on either side of the bridge were started simultaneously with a concrete plant on each side. On the east side the plant was at the top of a hill and concrete was deposited in the piers through a gravity chute. On the west side derricks were required for the deposition of the concrete. Work on the piers was continued throughout the winter, the usual precautions being taken to guard against freezing. In the pier construction these consisted mainly in covering over the forms with tarpaulins and placing salamanders inside. By the Spring of 1912 the piers were completed and a cableway was erected slightly off center of the bridge so that the concrete could be deposited in the center arch rib without interference. By April, 1912, steel erection was started.

STEEL ERECTION—The steel erection commenced by placing on the top of each pier the steel-frame skewback for the arch rib. When these were all in place, erection of the smaller arch ribs was started. These ribs were framed on the ground into two halves and lifted into place by two derricks, one on either side as shown in Fig. 8. They were then bolted to the skewbacks and together at the crown and afterward riveted. The thrust from the steel ribs was not sufficient to change the stability of the piers, so they were erected from end to end of the viaduct without regard for balance load.

The erection of the large ribs was the last undertaken (Fig. 9). Each of these ribs was placed on the ground in the six pieces noted above and then there were erected between the tracks of the railroad on which constant traffic was passing three timber bents placed respectively at the center and the quarter points of the span. Upon these bents were placed longitudinal I-beams, which were afterward removed and from the I-beams were hung in their proper places the structural-steel framework for the transverse floor-beams. The main arch ribs were then erected in their short pieces from the piers to a point above the quarter-point timber bent, and were supported there by the I-beam hangers acting as struts. These hangers were the same ones which were utilized in the final construction of the bridge. They were framed

FIG. 8. ERECTING RIB REINFORCEMENT OF ONE OF THE SMALL ARCHES

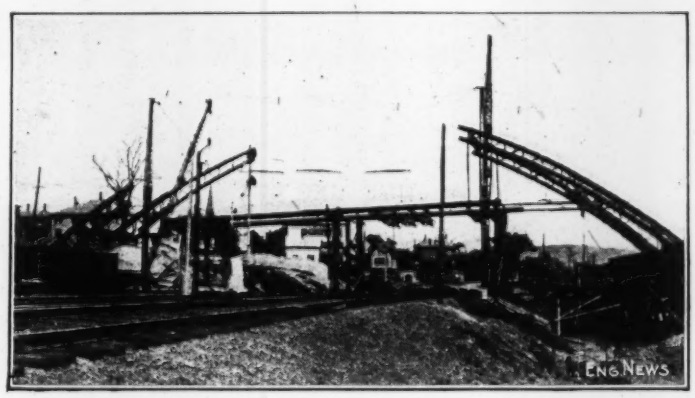


FIG. 9. ERECTING THE 204-FT. ARCH

at their top permanently to the arch rib, and at their bottom permanently to the floor-beams, which in their turn were hanging from the temporary I-beam stringers. The framing of the ribs was then carried across from arch to crown in this same manner, utilizing the hanger I-beams as struts. When the crown of the arch was reached it was bolted together and the arch allowed to take its set. The timber bents were then removed and the I-beams assumed their proper function as hangers,

supporting the steel frames of the floor-beams. The arch was thus erected with only the three timber bents as centers.

Concreting

The small arch ribs in triplicate were not braced together in the plane of the rib in the final structure, but during construction they were interbraced by means of timber planking attached to temporary gussets bolted into the steel ribs. They were removed as soon as the concreting was completed. In the main arch the steel cross-bracing was placed previous to concreting (Fig. 10).

Fig. 10. 204-ft. Arch under Construction

The concrete of the arch ribs was deposited in forms which hung from the steel reinforcing. The sketch in Fig. 11 shows the general detail of this method of forming. Holes were punched in the lower flanges of the reinforcing girders and through these holes were hung bolts which carried cross-timbers of 4x4-in. material. On these timbers longitudinal lagging was placed and separated from the bottom flange of the reinforcement by previously-cast concrete blocks of the proper depth, so that the lagging could be screwed up tight against the concrete blocks to provide the proper thickness of concrete protection of the lower flange. The side forms were made of vertical 4x4-in. studs with 1⅛-in. horizontal lagging, tightened by transverse bolts and separated at the top by struts. These side forms were allowed to overlap the bottom lagging so that they did not have to be cut to the intrados of the arch. Top boards had to be laid up to within a few feet of the crown to give the proper curve to the extrados.

After all these forms were in place across the bridge concreting was started for all of the smaller arches simultaneously. A hopper was erected at the crown of each arch with chutes leading to any place on any of the three arch ribs. One arch rib was then concreted from end to end of the bridge, the two outer ones first and the center one last. Concrete was mixed at the end of the bridge, carried by cableway to the hopper where it was dumped and thence shot through the chutes to its proper location. The construction of each rib was started at the pier and continued up daily simultaneously on either side of each pier, so that at any one time each pier was carrying a balanced load on either side. The thrust from the small arches on Pier 1 was not dangerous to that pier, so the concreting of the large arch was put off until all the smaller arches were completed. It was then carried out from each side to the crown as a single operation.

The further construction was a simple matter, as the arch ribs were quite capable of carrying the load of all the superstructure concrete. Ordinary forms were used on all of the work except for the floor-beams of the large arch where the forms were supported from the steel framework in somewhat the same manner as in the main arch for the arch ribs. The concreting was completed in December, 1912, and the bridge was opened Feb. 10, 1913.

Surface Finish.—A surface finish of the rubbed type was specified for the entire showing faces of the structure, but the contractor was allowed to modify this specification. The showing faces of the spandrel walls and arches were bush hammered and the remaining showing faces were washed with a 1:4 cement grout, thus making a pleasing contrast in the two sections.

Personnel

The bridge was designed by and built under the general supervision of James H. Fuertes, Consulting Engineer, New York, and was under the immediate direction of, first, Timothy Sheehan, and then F. C. Davis, successive City Engineers of Fitchburg, Mass. The contractor was the McHarg-Barton Co., New York City, and R. C. Dewar was superintendent for them on the work. The contractor was responsible for the method of erection and construction of the bridge, acting under the general supervision and approval of the consulting engineer.

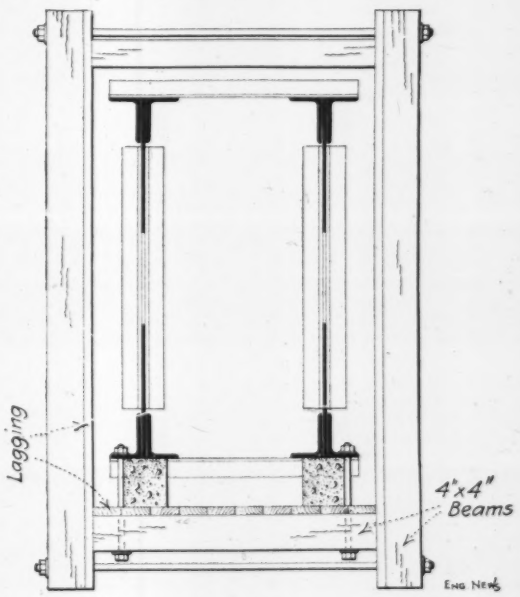


Fig. 11. Method of Hanging Forms to Rib Reinforcement, Fifth St. Viaduct

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Only Standard Weights of Steel Pipe are to be made hereafter by a number of prominent manufacturers in this country, which means that no more of the so called merchant grades are to be made by them. There have been some uses for pipe of lighter weight than that generally found advisable for most service, and, to cheapen construction where such pipe was permissible, the so called "merchant weights" were produced. The objection has been made, of course, that the "merchant weights" were substituted where full standard weights would have been better, and that this has been done without the knowledge and consent of the ultimate purchaser. It is obvious that full weight pipe is suitable for all purposes where merchant pipe has been used, though the opposite is not true. It is considered that the general advantages due to preventing substitution of light-weight stock outweigh any increase in the cost of work where a legitimate installation of merchant weights could have been made.

A Railway Grade Crossing with Steel Foundation

The maintenance of track in good alignment and surface at grade crossings is a difficult matter in most cases, owing to the tendency of the traffic to shift the crossings out of position as well as to crush the ballast which supports it. A solid concrete base has been tried and found too rigid, and although a concrete base covered with ballast has been proposed,* this design has never been carried into execution. An interesting development in this direction is the use of steel longitudinals to carry the rails at the crossing, these being connected to form a unit structure, so that the rails are maintained permanently in proper position. This system, which is described below, has been applied to a grade crossing on Ohio Ave. at Muncie, Ind., where the single-track electric line of the Indiana Union Traction Co. (on a curve of 117.07 ft. radius) crosses the two parallel main tracks of the Cleveland, Cincinnati, Chicago & St. Louis Ry. L. H. Mitchell, Superintendent of Roadway of the electric line, informs us that the daily traffic averages 64 electric cars and 18 steam trains, together with a small amount of switching.

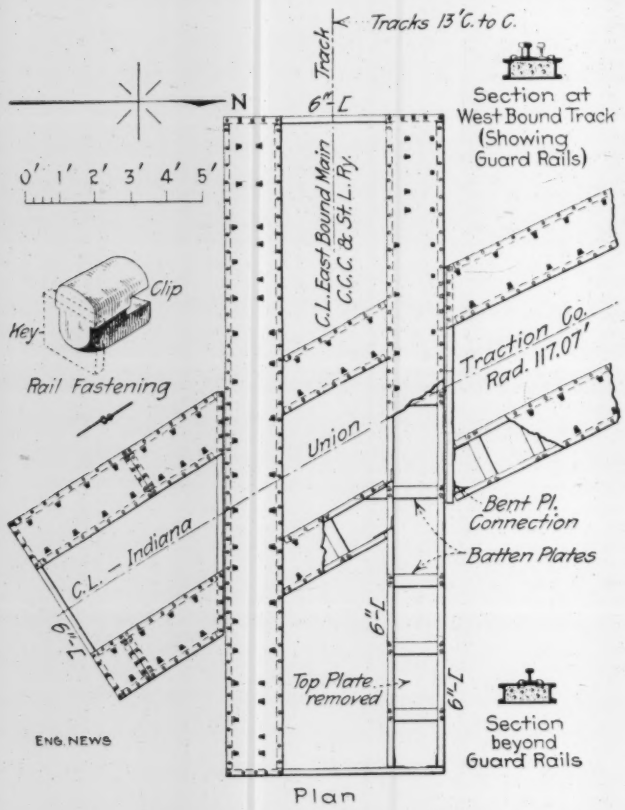

FIG. 1. PART PLAN OF STEEL SUBSTRUCTURE FOR THE GRADE CROSSING OF THE ILLINOIS TRACTION CO. AND THE C., C., C. & ST. L. RY., AT MUNCIE, IND.
(International Steel Tie Co., Cleveland, Ohio, Builders)

The design of this crossing support is a development of the steel-tie construction described in our issue of Mar. 30, 1911, in which each tie consists of two transverse channels or I-beams placed back to back, about 3 ft. apart, and connected by batten plates. This construction is said to be now in use on 22 railways, both steam and electric. For the crossing, each rail is carried on a longitudinal composed of two 6-in. channels 16 in. apart (with flanges outward), connected at the top by a continuous plate $20 \times \frac{5}{16}$ in., and at the bottom by straps or batten plates $4 \times \frac{5}{16}$ in., 2 ft. apart. The crossing was shipped in five pieces; one for each steam track (with cross-pieces for the electric track) and the others for the electric track between and outside of the former. Both ends of each piece were closed by a 6-in. transverse channel, riveted to the longitudinal channels by short angles or bent plates, thus forming a complete box. About three weeks before this substructure was assembled and installed, each longitudinal was filled with concrete, in which light reinforcing rods were embedded. The crossing was placed on a bed of clean stone ballast, which was well tamped under each longitudinal, the tamping being done from both sides. Ballast was afterward filled in to the level of the tops of the channels. Fig. 1 shows the construc-

*Engineering News, Apr. 29, 1909.

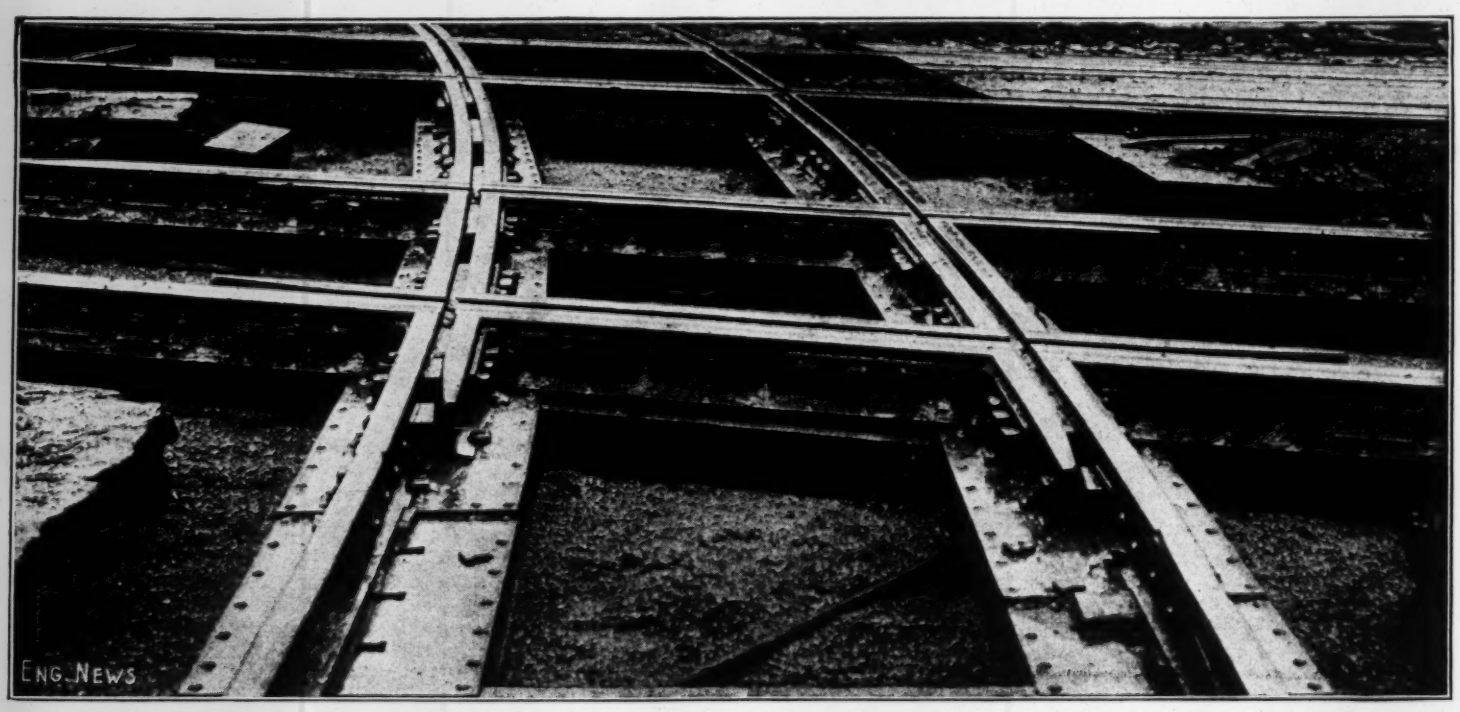

FIG. 2. GRADE CROSSING WITH STEEL SUBSTRUCTURE; MUNCIE, IND.

tion of the crossing, and Fig. 2 is a view looking along the electric line.

The entire crossing is laid with 90-lb. rails of the Am. Soc. C. E. section, as used on the main tracks of the C., C., C. & St. L. Ry. The electric line has 80-lb. rails of the same type south of the crossing, while at the north end it has 6-in. 72-lb. rails. The compromise joints at these connections are carried on the crossing substructure and the approaches are laid with steel ties of the type above mentioned. Both the steam and electric lines have inside guard rails extending through the crossing. The steam line has also a relieving rail outside of each track rail to carry the false flanges of worn wheels, the ends of the relieving rails being bevelled vertically so that the wheels will engage them without shock. The rail fastenings consist of grooved clips fitted to holes in the cover plates of the longitudinals, the groove embracing the top of the rail flange and the bottom of the cover plate. When the clip is driven into position a steel key is fitted behind it, filling the hole and preventing the clip from working loose. It is stated that the crossing is in good condition and that cars ride over it smoothly and without shock.

This substructure is the invention of Wm. P. Day (inventor of the steel ties already mentioned), Vice-President and General Manager of the International Steel Tie Co., Hippodrome Bldg., Cleveland, Ohio. He informs us that it is being installed also at four crossings at Lorain, Ohio., where the Cleveland, Southwestern & Columbus Ry. crosses the New York, Chicago & St. Louis R.R.

Foreign Associations of Consulting Engineers

In the last decade there has been a general movement among consulting engineers to form professional protective associations, with the object of maintaining high professional standards. The formation of the Association of Consulting Engineers in London last year directed attention to this movement most prominently, on account of the difficulties met in organizing that body. The American Institute of Consulting Engineers, with its headquarters in New York City, had been formed a few years previously as an active body, though the organization existed in rudimentary form as early as 1905. In 1911 consulting engineers on the Pacific Coast formed the Pacific Association of Consulting Engineers.

How general is the movement for professional union among consulting engineers can be gathered from a review of the subject published by K. Perlewitz, of Berlin, Germany, in a recent issue of "Technik und Wirtschaft" under the title "Die Beratenden Ingenieure im Auslande, ihre Organisationen und ihre Gebührensätze." According to this article, there are such professional associations in Germany, Austria, Holland, Sweden, Norway, Denmark and Belgium, besides the English and the two American societies already mentioned. But of all these only four, the German, Swedish, English and American societies, have more than a very small membership (the four range from 30 members to 80 members).

The nature and functions of the consulting engineers' societies differ appreciably. Some societies limit their membership strictly to independent consulting engineers, i.e., those who do nothing but consulting work (including in this term designing and supervisory engineering); the English and American societies are especially strict in this regard. On the other hand, several societies admit engineers in the employ of corporations. These latter societies, of course, should not be included in a list of consulting engineering bodies, but must be classed with the ordinary engineering societies in which both engineers in independent practice and engineers on a salary, as well as municipal engineers and the like, may take membership. As to functions, it is noted that several of these societies have established codes of fees. Two or three have formulated codes of ethics.

None of the existing societies is more than three years old. However, electrical consulting engineers formed organizations in Germany and in Austria as early as 1903 and 1905, but these bodies could not gather strength and vitality enough to survive.

A notable condition exists in Austria at the present time, as the result of recent legislation which requires consulting engineers to form professional organizations by districts, and requires every consulting engineer to belong to the professional organization of his district. This is in part the outcome of a practice which grew up without governmental action. For the last half century, Austria has had what was known as certified engineers, "behördlich autorisierte Ingenieure." This title, granted upon passing a difficult examination, gave the right to engage in consulting service to private or public parties. The certified engineers in different parts of the empire formed local associations for promoting their professional interests. The recently enacted law practically adopts the association idea and makes it a necessary qualification for the practice of engineering.

The Boston & Eastern Electric R.R. whose attempts to secure rights to build a high-speed electric railroad from Beverly and Danvers, Mass., to Post Office Square, in Boston, have been noted in "Engineering News," Aug. 20 (p. 196), Nov. 5 (p. 504), Dec. 10 (p. 644), 1908, and June 9, 1910, p. 686, has finally secured a charter from the Massachusetts Secretary of State, following advices from the Railroad Commission. The final location provides for stations in Beverly, Salem, Lynn, Boston, Chelsea, Danvers, Peabody, Saugus, and Revere. The line will be double-track, standard-gage, 13 miles long, with a 3½-mile branch from Salem to Danvers. The final estimate of cost of construction as filed shows a total figure of $12,975,000, compared with $10,973,000 in the 1908 estimates. The latter also included a signal system ($100,000), power stations ($800,000), distribution system ($340,000), shops, etc., ($120,000), and 50 cars ($843,000), all of which items, being viewed as equipment, are not included in the above final construction cost.

The Longest Single-leaf Bascule Bridge ever built is the 235-ft. bridge carrying the Baltimore & Ohio R.R. over the Calumet River at South Chicago, Ill. This bridge has just been completed and was given its official inspection and trial on Feb. 10. The bridge has a span of 235 ft., and the clear width of channel opening is 140 ft. on the square, the center lines of the bridge and channel having a skew crossing of 50°. It is a double-track structure, with through trusses spaced 31 ft. 3 in. apart c. to c. Adjacent to the bascule span are a tower span of 50 ft. and an approach plate-girder span of 65 ft. The total weight of structural steel is about 1300 tons, and that of the machinery is 125 tons, while the total weight of steel in the main or bascule span is 510 tons. The counterweight is of concrete, reinforced with steel rods, and has a volume of 1000 cu.yd., weighing 4000 lb. per cu.yd. or about 2000 tons in all. The machinery is operated by two electric motors of 100 hp. each (both working together); two 5-hp. motors operate the rail locks at each end of the bridge, and a third 5-hp. motor operates the bridge lock at the far end of the span. The bridge was designed by the Strauss Bascule Bridge Co., of Chicago, and is of the "heel-trunnion" type described in our issue of May 2, 1912.

Interference between Oil and Gas Wells and Coal Mines

On Feb. 7 and 8, a conference of coal operators, engineers, oil and gas men, geologists and inspectors was held at Pittsburgh under the auspices of the U. S. Bureau of Mines, to discuss the difficulties encountered where oil and gas wells penetrated coal fields, and remedies available. From the papers and discussions there presented the following extracts have been taken:

Troubles Resulting from Proximity to Gas and Oil Wells

By L. M. Jones*

The relation of gas and oil wells to coal mines has been investigated by inquiring into the past and present operating practice of each and noting wherein accidents and troubles have resulted or are likely to result.

ABANDONED WELLS—Until very recently, there had been no legislation in any of the states requiring the filing of an exact location of a drill hole, and the legislation covering plugging has for the most part not covered the case thoroughly, and has been difficult to enforce.

On this account in some of the old oil and gas fields large numbers of wells have been drilled and for one reason or another have been abandoned, not plugged at all or inefficiently. Where these wells have passed through coal beds which at a later period have been opened, a number of accidents have been caused by the unexpected piercing of the wells and the resulting liberation of large volumes of natural gas.

SEEPING OF OIL—There has been a number of cases where oil has oozed through the coal from wells whose location was not accurately known, the surface indications having entirely disappeared. There have been other cases where oil has entered the mine through the coal from some neighboring well, in one case in sufficient quantity so that a pump was installed to care for it.

WELLS WITHOUT VENT—A second group of troubles was from wells which have been improperly or incompletely cased and sealed, or which have no vent to the surface for gas which has collected in the casings.

UNPROTECTED CASINGS—Greater precautions should be taken properly to seal all wells from the coal beds and to provide a vent to the surface for any gas that may collect in the casings.

There is always a possibility of danger from wells, the casings of which are unprotected from mechanical damage, passing through the workings of an operating mine. I have heard of no case where serious accident has resulted in the mines from such a condition but many such wells are a constant menace to the safety of the mine on account of the fact that the exposed condition of the casing renders them more likely to be injured than if they were inclosed by a protecting wall or pillar of some character.

BENDING OF CASING—In a mine in Western Pennsylvania a casing of an oil well passed through a working and when the room pillars were pulled, subsidence of the overlying rocks bent the casing to such a degree that it was no longer possible to operate the rods in the well. In case of this kind it would probably be impossible to plug the well effectively on abandonment and it would remain a menace both to present mining and to the possible future deep mining.

CASING BENT BY WRECKS—In another mine near Pittsburgh the casing of an abandoned well imperfectly plugged is between the haulage tracks on a parting, and wrecks of trips have hammered it to such an extent that the casing midway between bottom and roof is 7 in. out of line. The inside of this casing is plugged with concrete for 50 to 60 ft. below the mine floor but some gas and salt water comes up on the outside of the casing into the mine. The plugging of the well in this case is not satisfactory since although little or no gas rises through the casing to the surface, gas does come up outside the casing. The well should have been plugged below the casing and the casing sealed with cement.

PROTECTION OF EXPOSED CASINGS—Several methods of protection for casings exposed in mine workings are in use. One large company has adopted the plan of building a 13-in. wall of brick set in cement mortar around the well.

Concrete walls have frequently been built around wells to protect them from injury.

If pillars are to be withdrawn a pack wall may be built of slate around an interior filling of clay. This wall would partially support the roof and prevent sudden falls of great weight badly bending or rupturing the casing.

DANGER FROM DRILLING OPERATIONS—Another class of operations has sometimes been a source of annoyance and disagreement between the mining and well drilling companies This is the case in which wells have been drilled through operating mines in such a manner as to inconvenience the operation of the mining or even to endanger the safety of the miners and mules.

Probably the most aggravating of such cases had been where the well has been drilled irrespective of whether there were mine workings beneath or not. I have heard of no case where a human being has been injured in such cases but two cases have been mentioned where mules were killed.

One of these occurred in Illinois fifteen or twenty years ago when a string of tools broke into an underground stable and killed a mule. The other instance occurred more recently in Pennsylvania in which case the tools broke into an entry and killed a mule that happened to be passing that point.

LEAKAGE DURING DRILLING—A well was drilled through Rice mine near Bergholz, Ohio, some time ago which gave some trouble. The hole was drilled through a room and the casing was driven down 10 ft. below the coal. The hole was then drilled to a depth of 700 ft. to the Injun sand when oil and some gas were struck. The oil and gas came up outside the casing, and although a cement block had been built in the mine around the casing, entered the mine through crevices in the bottom.

The mining and driling operations were both suspended until changes could be made. A second string of casing was placed in the well with rubber packers above the oil-producing sand and 60 ft. below the mine floor. Liquid cement was run in between the original casing and the new one from the packer to the surface. No further leaks were found in the mine.

INFLOW OF SURFACE WATER—Another possible source of damage which may result to the mine from drilling operations through the mine workings is the inflow into the mine from the drill hole of large amounts of surface water. Such a case occurred in Ohio by a well passing through a Zerbe mine. The well was cased to a point below the coal and a concrete block had been built around the casing but the flow of water could not be stopped. The casing was pulled out and the hole filled to a point above the roof with cement. The casing was then lowered into the liquid cement and the cement allowed to set inside and outside the casing. Afterwards the hole was drilled through the cement inside the casing. This method stopped the inflow of surface water.

DESIRABILITY OF AGREEMENT—These instances show the desirability of an agreement between the well drilling company and mining company as to the location of wells through the mine workings and an agreed method by which such work shall be done so as to safeguard the mine from inflows of gas, oil or water and to safeguard the wells from damage due to mining operations.

In some fields the wells are very close together, 100 to 400 feet apart, and in such cases the mining development is a very difficult proposition.

A plan showing a projected mine development in West Virginia gives an illustration of the seriousness of the problem when coal pillars must be left to protect the wells. In this case the projected underground development work was staked out on the surface and the wells were located so that 100-ft. pillars surrounding them would not necessitate curving the entries.

In cases like this last the situation is aided somewhat by the willingness of the drilling companies to so locate their wells as to inconvenience the coal development work as little as possible. Most of the large coal and gas and oil companies in Pennsylvania and West Virginia have been willing to coöperate in this manner so that the development of either would inconvenience the other as little as possible.

When a gas or oil company desired to drill a well in a certain place they furnish the coal company with the location to determine whether there is any objection on the part of the mining company to it. Where wells would interfere with projected development work or would be difficult, changes in location are made to meet these objections.

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Gas and Oil Wells in Coal Fields

By George S. Rice*

The problem of gas or oil wells extending through or near coal mines, and through the future coal reserves, has gradually become more and more serious, not only on account of the danger to the miner, but also because there has been an increasing loss of coal left as pillars surrounding the wells. Fortunately so far there has not been a large loss of life in mines through explosions or fires caused by leakages of gas from wells, but there are a number of cases on record in which lives have been lost, and the possibility of occurrence of disasters has been present in a number of instances.

Wells are constantly being drilled in the coal fields of this country, and are very numerous in the coal basins of Pennsylvania, West Virginia, Ohio, Indiana, Illinois and Kansas. In Pennsylvania and West Virginia mines not infrequently strike abandoned, uncharted wells. In many cases these have been found filled with gas, and in some instances the gas has been lighted. Recently a serious fire was caused in a mine in the vicinity of Pittsburgh, through burning gas which had been ignited when an unknown well was struck in mining operations. Fortunately this was not attended by an explosion, but it led to the mine being shut down for a couple of weeks, and the bureau's engineers and rescue crew had to be called upon to investigate behind the fire stoppings. In a number of cases where wells have been encountered, there have been narrow escapes from explosions. It would therefore appear that the industry hitherto has been more lucky than far seeing, in not taking precautions in making secure and in recording the location of abandoned holes, which, while not giving gas in commercial quantities, make sufficient to be very serious in mining.

Hitherto the legislation on gas and oil wells in all the states except Ohio and Indiana, has dealt with the subject only from the standpoint of protecting the wells from one another. The Ohio laws, and to a lesser extent the Indiana laws, take some cognizance of the dangers to mining in the vicinity, but they are considered inadequate.

The problem of formulating laws is not one which alone concerns the coal operator and inspector, but it also concerns the gas- and oil-well operator. The latter must be given the opportunity to search for and obtain the gas and oil under their option or ownership. It is manifest that they wish to take reasonable precautions for safety, but do not wish to be put to unnecessary expense, or to be prevented from drilling wells in coal fields; therefore some means must be found by which the wells can be drilled through or in the vicinity of the coal mines without creating dangerous conditions. Three parties are therefore vitally concerned; the gas and oil well operator, the coal operator and the miner, whose safety is looked after by the State Mine Inspector. The State Geologists are interested from the standpoint of conserving oil and gas as well as coal. The United States Bureau of Mines is concerned both in the conservation of all mineral resources and in the safety of the miners; for which reasons it is desirable to have good as well as uniform rules and regulations throughout the country.

At preliminary meetings, the members of the Bureau of Mines staff prepared a tentative outline of rules and regulations which might serve as a basis for possible legislation on the subject of oil and gas wells through coal measures. The rules to be added to or modified in detail to suit the particular conditions which prevail in the respective state.

There are several features which have been discussed but which have not been incorporated in the rules and regulations, as it was felt that it was rather a matter of gradual development and, in certain cases, of private agreement between the parties at interest. These questions are as follows:

SIZE OF COAL PILLARS—It has been found that the pillars that have been left around gas wells in Pennsylvania and West Virginia vary from 40 ft. diameter or square, to 200 ft. diameter or square, the well being at the center. It was found that the various sizes merely represented opinions of the parties concerned, or compromises between interested parties. The courts, in rendering decisions, would appear to have determined arbitrarily the size of pillars that must be left in certain cases, presumably the size determined in each specific case representing the consensus of testimony that was presented.

It was conceded that pillars of coal of any reasonable size did not prevent leakage of gas into the mine when there were defects in the well casings, but that they served as supports to the overlying strata to prevent fracturing or breakage of the well casing anywhere from the coal seam upward to the surface.

Looking at it from this point of view, the question of size of pillar surrounding the well is a problem similar to that which has arisen as to the proper size of pillar to be left surrounding a mine shaft. Investigation by the bureau has not disclosed any uniform system of determining the size of a shaft pillar, but there have been a number of empiric formulas used by mining engineers in the various mining countries.

A formula used for barrier pillars in the anthracite district, by a number of prominent companies, and approved by one of the state mine inspectors is as follows: "The width of the barrier pillar is equal to the thickness of workings multiplied by 1% of the depth below natural drainage level, plus the thickness of the workings multiplied by five."

The necessity of protecting a shaft is doubtless greater than for a gas or oil well. It is the means of egress, and it is not simply the protection of the shaft itself that must be considered, but also the support of the surrounding buildings, including the engine and boiler plant; hence there is greater need in having large pillars surrounding shafts than around wells.

The Consolidation Coal company in the Fairmont district, is considering the necessity of leaving 200-ft. pillars surrounding the wells. A plan will be shown which indicated how serious this condition may be when the wells are close together, either from the standpoint of laying out the mine, or from the loss of coal in the pillars. This brings up the question whether or not it is necessary to retain the pillar permanently.

EXTRACTION OF COAL SURROUNDING WELL

It might be possible to dispense with a coal pillar around an oil or gas well provided an artificial pillar was substituted. This proposal is not quite so radical as it might seem at first. The coal surrounding shafts has been extracted in some of the longwall mines in Great Britain, and in one longwall mine in northern Illinois, without detriment. Where this plan has been employed, the section from which the coal has been excavated is carefully packed with broken rock and dirt, as is usually done in "longwall advancing" so that the movement downwa d is very gradual and even, the strata all the way to the surface subsiding evenly, and without damage to the surface buildings, provided the longwall face advances regularly. The final surface subsidence where the goave has been well packed with dry packing, is about 50% of the thickness of the excavation; that is, in a bed of coal 6 ft. thick the subsidence would be about 3 ft.

To suit the room and pillar conditions, the writer suggests the following plan: That a room be laid out so that the drill hole will be approximately in the center; in drilling the well, the hole to be made 2 or 3 in. larger in diameter than the outer casing which is to be inserted, so that there is a space of from 1 to 2 in. surrounding the casing. Let us suppose this outer casing is to go 30 ft. below the coal bed, then the larger size hole will be drilled an additional distance equal to the thickness of the seam, below where the shoe of the casing is to hang. The casing will then be lowered and hung from cross beam supports at the surface, the ends of which are to be placed on piers so as to make the supports permanent. These cross beams should be steel channels or girders, 8 or 10 ft. or more in length, and of sufficient strength to hold the weight of the casing. Before lowering the casing a gasket of rubber or canvas is to be fastened just above the shoe around the outside, so as to fit against the rock or shale when the casing has been lowered to place and hung from the beam supports; a grouting of clay will be run in between the casing and the sides of hole so as to completely fill the space from the gasket to the surface. This is to allow an opportunity for the casing to slide freely, either at the bottom or the top if the coal is excavated and the ground subsides. After the casing has been put in and grouted with clay, the drilling and putting down of the inner casing will proceed in the usual manner. When subsidence of the ground occurs the arrangements spoken of will be equivalent to an expansion joint in a steam line. The inner casings and the gas tube being rigid and fixed below, when the subsidence takes place will merely project that much further above the surface of the ground, and will not be effected by the subsidence.

It is, of course, assumed that a space will always be left open to the top between the outer casing and the next inner casing, so that if there are any gas leaks it will be vented to the surface, in accordance with the plan employed in recent wells where by agreement with the coal companies precautions have been taken.

LOWER COAL BEDS—If abandoned wells are properly

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plugged from bottom to top, there would seem to be no need for other special precautions for deeper coal beds. It is manifest that in the great majority of cases these coal beds will not be worked for many years to come, perhaps 25 or 50, or as much as 100 years. It is also manifest that no casing would resist corrosion for such extended periods, therefore it is believed that the project of restoring the strata to practically the same strength and impermeability as originally found will be the best method. All the geologists in attendance at the recent meeting agreed that this was the best solution of this problem.

PLUGGING ABANDONED WELLS—It was further agreed to by the geologists that the simplest and safest way of handling abandoned wells through coal mines will be to plug them tightly all the way from the bottom to the surface. If holes are plugged so that there is no leakage of gas, there would seem to be no danger in laying out a mine, or in the working of same, without the necessity of paying attention to an abandoned hole, beyond approaching the hole carefully, and testing to see whether there is any sign of leakage of gas. This assumes that the plugging of abandoned wells in coal districts shall be done with an inspector present, preferably a gas- and oil-well inspector appointed by the state; and that a certificate showing that the plugging has been properly done, has been duly recorded.

MAPS OF PROJECTED WORKINGS—It is undoubtedly a most excellent plan for the gas and oil well operator, and the coal operator to come together and agree upon a suitable location for holes. To do this intelligently the coal operator should furnish the gas and oil operator a plan of his projected workings. It is assumed that the site of the proposed well shall be carefully surveyed to and located, and that the map of the location and at least the record of the casing as deep as 30 feet below the coal bed that is being worked, shall be matters of public record.

DRILLING THROUGH INACCESSIBLE MINE WORKINGS—The question has arisen in several cases as to the protection from leakage of a gas well drilled through an inaccessible mine opening or excavation, as for example where pillars have been pulled. In the case of leakage, there would be danger of the goave filling with gas which would escape into the active mine workings. As the courts have held that the parties possessing the gas ownership have the right to drill, it is necessary to consider how this can be done with a minimum amount of danger. All have conceded the necessity of having an outer protective casing open at the top to the atmosphere, but in the event that acid mine water may corrode it, additional protection is necessary. One plan is to make the hole large enough to insert an outer pipe opposite the coal bed and fill between it and the casing with cement. This plan seems to be an excellent one and worthy of trial. An alternative scheme might be used when the mine excavation is not too much filled with débris. When the drill has entered the excavated space and drilled through any loose rock to the bottom, fill the space with a concrete mixture of crushed rock or gravel, sand and cement, thoroughly mixed. This is to be put in rapidly, and will, if of proper consistency, form a conical heap with the apex at the top of the open space. A conical bit or tool fixed on the end of the string of tools will then be immediately lowered and used to spread out the top of the cone more concrete must then be put in and again spread out by the conical tool. The concrete should then be allowed to set, following which a hole will be drilled through it by the usual method. This hole may be a small one. Then liquid cement will be run in and forced under pressure to fill the interstices after this has set it is anticipated that there will be a strong concrete column through the mine excavation, which will be practically impervious to the mine water, and through which a hole of full size can be drilled as through a solid rock stratum, and the casings inserted in the usual manner.

Suggestions for Laws and Regulations

By O. P. Hood* and A. S. Heggem*

The following suggestions are an attempt to harmonize as far as possible the information and advice which has so far been available to the Bureau. There has been no attempt to put these suggestions in proper legal phrase nor to make them entirely complete, but only to form a basis for discussion and further suggestion by this conference to the end that suitable laws may be suggested to the various states in order to make the business of mining more safe and to prevent mineral waste.

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It seemed to be the general opinion that some form of inspection is necessary in order to make operative any laws which may be enacted, and which required specific methods or results.

In order that it shall be possible to accurately locate a well which goes through a workable coal seam, and which may at some time be within a mine area, it seems desirable to require a license to drill.

In order that the wells shall be properly plugged when they are abandoned, it has been suggested that the well driller shall furnish a bond which is to be returned to him when the plugging has been properly done.

These suggestions cover only those wells which are put down through workable coal seams. A definition of this term "workable coal seam" is so difficult that it has not been attempted, and the responsibility for a reasonable interpretation of this phrase is placed on the State Geologist whenever the matter becomes one of dispute.

It is believed that the location of a bore hole should be so accurately determined that it could at any time be relocated, even after all surface indications have disappeared; and for this purpose it seems necessary to have the survey made by competent persons and reference made to established boundaries which can be located only by reference to at least three monuments or reference points.

In order that gas may not be drawn into the ventilating system of any mine, a minimum distance from a mine opening has been provided, and a similar minimum distance to those buildings which are vital to the safety of operation of a mine, so that in case of fire, of either wells or mine buildings, the risk shall not be increased. It seems evident that a bore hole should not go through any mine haulage or air way, and in order to insure this a distance of 15 ft. from such mine haulage or air way is required. It is believed that if pillars are considered necessary about such a bore hole, that the supporting power of the haulage way ribs will be sufficient.

In requiring casing from surface water, it is believed that, after the casing which goes through the coal seam is properly placed and packed as required, then the one used for excluding the surface water may be withdrawn. The double casing which is required through any coal seam is deemed necessary in the event that a mine should be opened and the casing possibly exposed to corrosion or injury from the movement of ground. In order that the ground pressures shall be applied over a considerable surface of the casing, it is required that they extend into the floor a sufficient distance; that they be surrounded with a clay pack; and that the second casing shall be brought into play through a similar clay pack. The use of clay for a packing material was preferred rather than cement, to avoid possible cracks through which corrosive water might enter if the outer casing was penetrated, and also to prevent the localizing of stresses on the second casing.

In the arrangement of casings and casing head, it is proposed to insure a free vent to the atmosphere from a point in the well below any of the casings used and to insure that this vent shall be maintained by openings that cannot be readily closed.

Where oil is allowed to rise within a casing above the floor of a mine, it may find its way past the several casing seats and into the mine, so that it seems necessary to keep the level of any such oil below the mine floor.

The matter of abandoning a well has been made a formal matter, so that a proper record shall be made and there be assurance that the work is properly done.

In suggesting a plugging method, it has been attempted to keep the method as simple and as general as possible. The method is based on the theory that while clay alone may make a good stopping that it may also flow and not be maintained where it is believed to be. Also, that cement mortar or concrete is apt to be porous, to deteriorate in oil, and to form a plug of doubtful tightness. It has, however, the quality of probably staying where it is put. To combine these two qualities it is suggested that there be a portion of cement with clay available at each end of this portion, so that if there is any movement of fluids through the cement, the clay will be carried into small openings and eventually close them. It also seems desirable that there be a hard solid portion through any coal seam, so that if struck by mining tools it is immediately disclosed.

OFFICES

METHOD OF APPOINTMENT—A chief inspector of gas and oil wells shall be appointed by the Governor from an eligible list of men who have passed a satisfactory examination showing technical fitness for the position.

SALARY—The yearly salary of the chief inspector of gas and oil wells shall be ——— dollars. Necessary travel expenses to the amount of ——— shall be borne by the state

and an office equipped with suitable filing arrangements provided.

ASSISTANTS—Assistant inspectors of gas and oil wells, subject to the authority of the chief inspector, may be appointed by the Governor.

DEPUTIES—Competent men may in an emergency be deputized by the Chief Inspector to perform the duties of the position in the field, but an appeal from his decisions may be had to the Chief Inspector. Deputies may receive not over ——— dollars per day and actual expenses not exceeding ——— dollars per day.

DUTIES

LOCATION—It shall be the duty of the inspector to receive applications for permission to drill bore holes and issue a license to drill to persons who comply with the law.

The inspector shall receive and file maps giving the location of bore holes; shall determine the sufficiency of such maps for the purpose of accurately locating such bore holes, and shall cause a new survey of such location in case of insufficient maps.

It shall be the duty of the inspector or his assistant to examine the maps accompanying applications for permission to drill bore holes, and where the location is in the vicinity of a mine he shall immediately proceed to the site and notify the district mine inspector and the coal operator to state whether the location on the map accompanying the application to drill is such as will interfere with the safe and economical operation of the mine.

The inspector shall issue a license when the proposed location of a bore hole is such as not to interfere with the safe and economical operation of a mine, as determined by the mine owner, state mine inspector and himself. To this end he shall have the power to move the location of a proposed hole as hereafter specified.

After hearing and duly weighing the evidence he shall permit the bore hole to be drilled at such point as will in his judgment permit the safe and economical operation of the mine.

RECORDS—It shall be the duty of the inspector to keep a complete record and prepare for publication a yearly report of the number of wells drilled in his district together with their location; date of completion; depth; production; date of abandonment and name of owner.

SUPERVISION—It shall be the duty of the inspector to examine each well in his district at frequent intervals, giving special attention to all wells containing gas in quantity which may be, in case of leakage, a menace to a mine, and to see that all the provisions of this act are observed and strictly carried out.

COMPLAINTS—He shall receive and investigate all complaints as to injury, present or impending, due to a lack of precaution on the part of any well owner or mine operator, and if he finds the complaints against the latter well founded he shall lay the facts before the state mine inspector.

PLUGGING WELLS—Upon receiving notice of intention to abandon a well the inspector or his assistant shall proceed to such well and satisfy himself that the provisions of this act referring to plugging wells are complied with. He shall join the owner in making affidavit to the manner in which the well has been plugged.

VIOLATIONS—If the inspector discovers any well being drilled, operated or plugged contrary to the requirements of this act, he shall order the workmen engaged upon such well to cease work at once and until the law is complied with.

ENFORCEMENT OF LAWS—To enable the inspector to perform the duties imposed upon him by this act, he shall have the right at all times to approach and examine any well in his district, and with the authority of the state mine inspector, enter any mine affected, and upon the discovery of any violation of this article or upon being informed of such violation, he shall institute proceedings against the person or persons at fault, under the provisions of the law provided for such cases.

In case of failure of the owner to properly plug an abandoned well, it shall be the duty of the inspector to have the work properly performed by contract and assess the cost against the well owner.

PENALTIES—(There shall be adequate penalties provided to aid in obtaining the safer conditions here proposed).

LOCATION

APPLICATION—Any person (firm or corporation) purposing to drill a bore hole through a workable seam of coal shall make application in writing to the chief inspector of gas and oil wells for permission so to do, and he shall not commence drilling until such permission, in writing, has been received by him. In case of dispute the State Geologist shall determine whether a seam of coal is workable within the intent if this act.

SURVEY AND MAPS—Accompanying the application for permission to drill such bore hole there shall be submitted a map showing the location of the proposed bore hole with reference by course and distance to the boundaries.

Said map must be made on a scale of 200 ft. to 1 in., and shall be based on surveys made by surveyors or engineers of recognized standing, and certified to by the surveyor or engineer making the same.

In case the inspector finds the map insufficient to enable him to accurately locate the proposed well, he shall require that another survey and may be made before permission to drill is granted.

If the original map is found to be correct the cost of the second survey and map shall be borne by the state.

BOND—Any person (firm or corporation) purposing to drill a bore hole through any workable seam of coal shall be required to give bond in the amount of ——— dollars to insure that the drilling and abandoning of such bore hole shall be in acordance with the provisions of this act.

DISTANCE FROM BUILDINGS, ETC.—No bore hole penetrating a gas or oil bearing formation shall be located within 300 ft. of a shaft or entrance to a coal mine not definitely abandoned or sealed nor within 100 ft. of any mine shafthouse, boiler or engine house, or mine fan. No bore hole shall be located to drill within 15 ft. of any mine haulage way or air way.

LICENSE—Should the proposed bore hole be so located as not to interfere with the safe and economical operation of any mine and the previous requirements of this act be complied with, a license shall be granted and said person (firm or corporation) may proceed to drill such bore hole in accordance with the further provisions of this act.

PROTECTION OF COAL MEASURES

CASING FROM SURFACE WATER—Any bore hole penetrating any workable seam of coal shall be cased by the owner of the bore hole with a suitable casing (conductor or drive pipe) so as to shut off all surface water from entering the coal seam.

CASING THROUGH ANY COAL SEAM—Any bore hole, drilled for gas, oil or other mineral shall be drilled to a point at least 20 ft. below any workable seam of coal which may be penetrated, and receive a metal casing not less than ¼ in. in thickness and of an inside diameter four inches less than the bore hole. This casing shall be concentrically seated on the bottom of the hole and shall extend to the surface and shall be known as the first casing.

A second inner casing 4 in. less in diameter shall extend at least ten feet below the first casing and be seated in 1 to 2 cement mortar 9 ft. in depth. The inside of the second casing shall be open to the atmosphere its full length.

The intervening spaces between the second and the first casings and between the first casing and the bore hole or outer wall shall be filled with puddled clay to a height 30 ft. above the coal seam.

CASING THROUGH ACCESSIBLE MINE EXCAVATION—Casings which pass through a mine excavation shall be protected by a wall of concrete or of masonry or brick laid in cement mortar, extending from 2 ft. below the mine floor to the mine roof. Between the first casing and the wall thus constructed there shall be left an annular space of not less than 2 in., which must be filled with puddled clay. This work shall be done by the well owner.

Casings which are exposed by mining operations shall be covered as above by the mine operator.

CASING THROUGH INACCESSIBLE MINE EXCAVATION—Where a bore hole passes through an inaccessible mine excavation the outer casing shall be protected by cement mortar held within a metal tube 4 in. greater in diameter than the casing end extending from 4 ft. below the mine floor to 4 ft. above the mine roof or cave.

CASING TO EXCLUDE WATER—Before drilling a bore hole into a gas- or oil-bearing formation a string of casing shall be so set as to exclude all water from the lower bore hole.

TUBING A GAS WELL—To conduct gas from a gas well, tubing shall be inserted with a suitable packer located below the inner casing and in such manner as to prevent the escape of gas except through the tubing.

The inner casing shall be left open to the atmosphere throughout its full length.

TUBING AN OIL WELL—To conduct oil from an oil well, tubing shall be inserted and extend from the oil bearing formation to the top of the well.

The inner casing shall be left open to the atmosphere throughout its full length.

Should gas be liberated in the well in sufficient volume to have commercial value it may be shut in by means of a packer placed below the inner casing and be conducted from the well through tubing inserted into the well parallel to the oil tubing.

CASING HEADS—Casing heads must have at least one opening to the atmosphere to which a valve or plug cannot be attached, so as to insure ample vent in case of leakage into casing spaces.

COMPLETION OF WELL—When a bore hole has been drilled and put into operation the owner shall file with the inspector a statement of the total depth of the hole, the sizes and lengths of casing used and remaining in the hole, the depth and thickness of all coal seams penetrated and whether oil, gas or water is obtained.

SUSPENDED OPERATION—When for any cause a bore hole which passes through a workable seam of coal shall cease temporarily to be operated, the inner string of casing shall be maintained open to the atmosphere. Should oil tend to rise in the well above the bottom of the first or outermost casing passing through the workable coal seam, such oil shall be pumped out by the owner and its level maintained below the bottom of this casing.

ABANDONMENT OF WELL

NOTICE OF INTENTION—When any oil or gas well is to be abandoned the owner shall notify the chief inspector in writing of such intent to abandon and proceed with plugging methods only after complete arrangements for inspection shall have been made and permission granted.

METHOD OF PLUGGING—In abandoning a well it must be entirely filled from bottom to surface. The lower hole must first be filled to a point 5 ft. above the lowest gas or oil bearing formation with sand, clay or rock sediment. Above each formation supplying gas, oil or water and immediately below any workable seam of coal there shall be a plug as hereafter described, and each well shall have not less than three such plugs whatever the formation.

This plug shall consist of 25 ft. of cement mortar made of 1 part portland cement and two parts of sand properly mixed and placed with a bottom dump bailer upon 5 ft. of clay resting on a seasoned wood plug 2 ft. long and of the same diameter as the hole. Five feet of clay shall also be placed on top of the cement section. The space between the plugs here called for must be filled solidly with puddled clay, sand or rock sediment, cement mortar or concrete. The filling shall be complete up to the bottom of a casing before such casing can be drawn and the filling shall continue length by length as the casing is withdrawn, using cement, mortar or concrete when passing through coal seams.

LOG OF METHOD OF PLUGGING—When a bore hole has been plugged an affidavit stating the method followed, the materials used and the distances occupied by each material shall be certified to by the gas well inspector and filed with the oil well inspector and a duplicate with the county recorder.

RELEASE OF BOND—After, and not until these several requirements have been met, any bond which may have been given by the owner shall be returned.

Azimuth by Direct Solar Observation

By Louis Ross*

Direct solar observations for azimuth, without any attachments whatever, are physically far more convenient than Polaris observations, and dispense with the many objections to the use of solar attachments. In practice, however, direct solar observations are sometimes discredited among engineers, being considered inaccurate and merely a bit of theoretic or textbook fiction. The writer has gradually developed during a number of surveys a method of making direct solar observations accurately and with great facility. With a rather second-rate reconnoissance instrument, the vernier of the vertical circle of which reads to 2′ of arc, he has habitually obtained an accuracy of 1′ of arc in azimuth, without difficulty, with comparatively small effort.

Figs. 1, 2 and 3 will refresh in the reader's mind the physical concepts and factors involved in solar work.

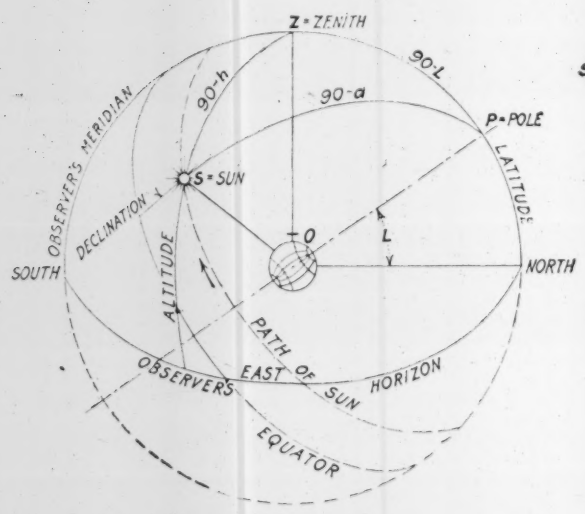

FIG. 1

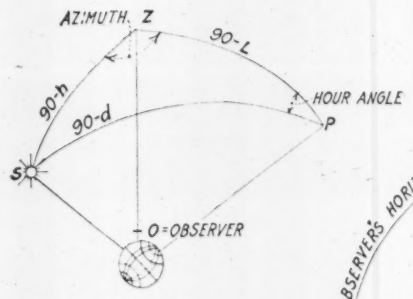

FIG. 3

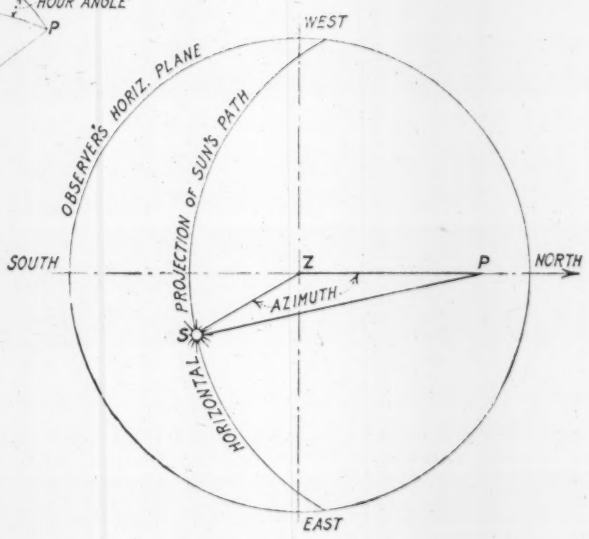

FIG. 2

FIGS. 1-3. ELEMENTS OF SPHERICAL TRIGONOMETRY INVOLVED IN A DIRECT SOLAR OBSERVATION FOR AZIMUTH

In Fig. 1, O is the position of the observer, who, having his zenith Z vertically above him, is more intelligibly conceived of as being situated "on top" of the earth; directly north, at an altitude equal to the observer's latitude, is the celestial north pole P; while to the south is the sun S, shown as it would appear on a summer morning, north of the celestial equator and bearing southeasterly. The relative size of the earth has been exaggerated in the sketch for the sake of clearness. Fig. 2 shows more clearly the azimuth Z, the quantity principally discussed in this article, projected on the horizontal plane in which the transit measures horizontal angles.

The general procedure is to measure the sun's altitude h, obtain from the solar ephemeris its declination d, and take from a map the observer's latitude L. These three factors are substituted in an equation of the form

$$Cos\ \tfrac{1}{2}\ Z = \sqrt{\frac{sin\ \tfrac{1}{2}\ s\ .\ sin\ (\tfrac{1}{2}\ s - (90\ d))}{sin\ (90 - h)\ .\ sin\ (90 - L)}} \qquad (1)$$

where

$$S = (90 - h) + (90 - L) + (90 - d) \qquad (2)$$

from which Z, the sun's true azimuth, is computed.

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CAUSES OF INACCURACY—Among the reasons why this method generally fails to give reliable answers are: erroneous readings, instrumental errors, the misapplication of the corrections to the declination and to the altitude, substituting the wrong functions of the latitude, and the errors in computing equation (1), which requires some 20 operations and is quite impracticable for field use. The remedy is to insure the accuracy of the data and to simplify the computation.

SIMPLIFIED FORMULA—In place of the orthodox equation (1), given by nearly all textbook writers on the subject, the writer has developed and uses the equation*

$$Cos\ Z = \frac{sin\ d\ -\ sin\ h\ .\ sin\ L}{cos\ h\ .\ cos\ L} \qquad (3)$$

which is derived from the cosine law of spherical triangles. The interested reader can easily prove this formula by referring to the elements of spherical trigonometry. This formula is not as awe-inspiring as the usual one, but is much more useful, requiring less effort to solve, with less chance of error. Tabular forms for computing this equation are given in Fig. 4—Table A, for logarithmic, and Table B, for arithmetic work. This formula is, of course, exact. It remains, therefore, to substitute the correct functions in this equation, and to facilitate its solution. This requires a clear, exact understanding of the quantities involved.

DECLINATION—The declination d as taken from the ephemeris, must be corrected for the longitude and time of the observation. The application of these corrections involves a mental effort and a consequent source of error. To obviate these errors Fig. 5, with its equation, has been devised. Its use and construction are obvious.

After obtaining the true declination its sine is used in equation (3). For any extensive survey it is a waste of effort and a source of frequent error to look up these declinations at each observation, apply their corrections, and look up their sines. To obviate this a table similar

*A modified form of the same equation,

$$Cos\ A = \frac{sin\ d}{cos\ h\ .\ cos\ L} - tan\ h\ .\ tan\ L,$$

is given in Johnson's "Theory and Practice of Surveying," 17th edition (1910), p. 99.

to Table I is prepared for several weeks in advance. This table gives *sin d* at noon of the average longitude of the survey, with the hourly change in *sin d*. Thus, for Nov. 10, 8:30 a.m., *sin d* is, from Table I, 0.2943. This quantity is directly substituted in equation (3), obviating the

The multiplications and division need be carried to four decimals only.

ANGLES		NAT. SIN	LOG SIN	LOG COS
d	+23° 27′	+.39 795		
h	20° 57′		9.55 334	9.97 030
L	34° 18		9.75 091	9.91 703
	Products	-.20 149	9.30 425	9.88 733
	Numerator	+.19 646		9.29 327
Z	284° 45′			9.40 594
ZL	284° 37′			
Z1	is 12′	to small		

LOGARITHMIC COMPUTATION

ANGLES		SIN	COS
d	+23° 27′	+0.39 795	
h	20° 57′	0.35 755	0.93 389
L	34° 18′	0.56 353	0.82 610
	Products	-0.20 149	0.77 149
	Numerator	+0.19 646	
Z	284° 45′		+0.25 465
ZL	284° 37′		
ZL	is 12′	to small	

ARITHMETIC COMPUTATION

$$\cos Z = \frac{\sin d - \sin h . \sin L}{\cos h . \cos L}$$

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FIG. 4. FORMS FOR COMPUTING EQUATION

field use of the ephemeris, field corrections, looking up functions, or the possibility of common errors. Northerly declination is considered positive; southerly, negative, for use in equation (3).

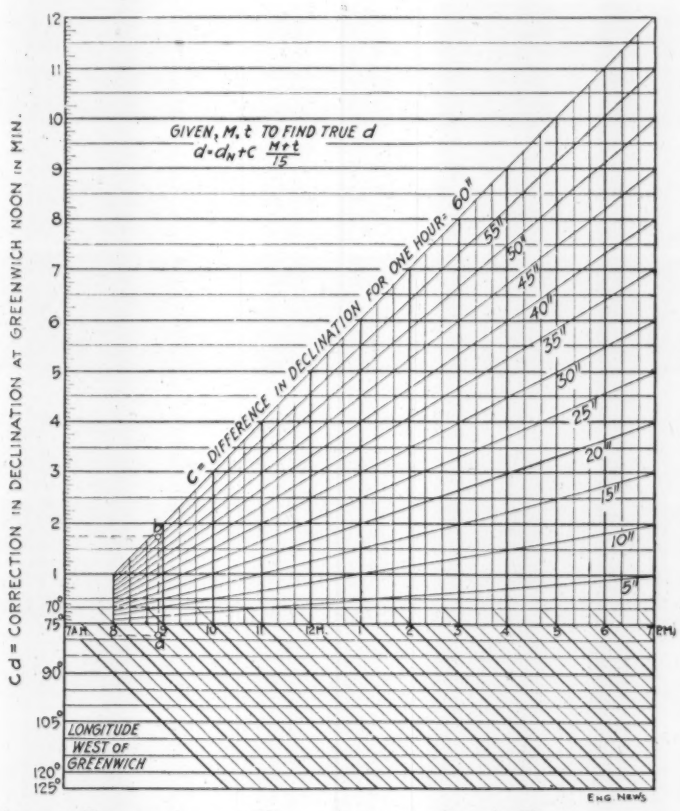
GIVEN, M, t TO FIND TRUE d
d = dN + C (M + t)/15
C = DIFFERENCE IN DECLINATION FOR ONE HOUR
Cd = CORRECTION IN DECLINATION AT GREENWICH NOON IN MIN.
LONGITUDE WEST OF GREENWICH
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FIG. 5. DIAGRAM FOR DETERMINING SUN'S DECLINATION

The error in azimuth caused by 1′ of error in declination is given by the equation

$$\frac{dZ}{dd} = -\sec L \ . \ \csc t \qquad (4)$$

where *t* equals the hour of observation, in degrees, a.m. or p.m. Table II gives numerical values for a few typically selected arguments, and will be found useful.

The longitude for correcting the declination, Fig. 5, need not be more accurate than within several degrees, and the time not closer than 10 to 20 min. To make the observer independent of a watch, Fig. 6 has been devised, from which the time may be quickly obtained to an accuracy of a few minutes. Its use and construction will be obvious to the interested reader. In using this figure or equation the azimuth *Z* obtained from the compass, to an accuracy of 3° to 5° is sufficient.

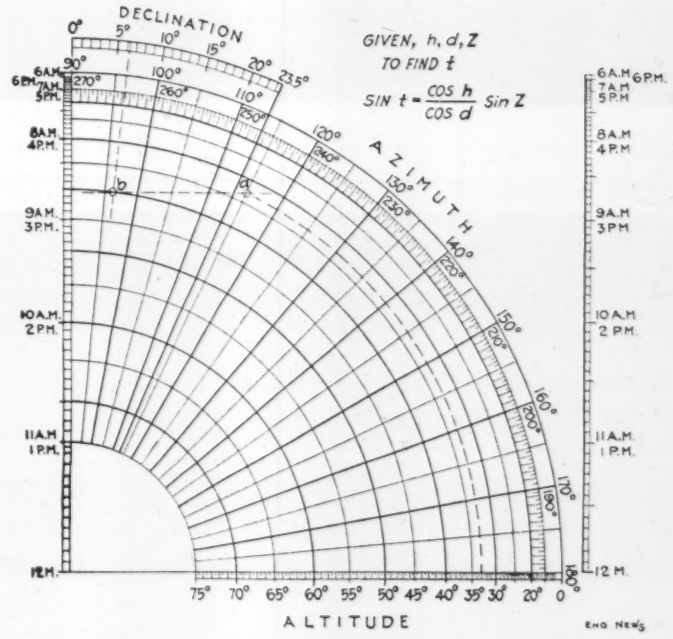

FIG. 6. DIAGRAM FOR DETERMINING TIME OF OBSERVATION

Given { Z = 115° 00′, h = 33° 04′, d = 6° 19′ } Find t.

Locate point a (az. 115° 00′ alt. 33° 04′); project a horizontally on rad. of decl. 6° 19′, locating b; swing b radially on time scale.

Then t = 8:41 A.M.

Note—The time scale is duplicated on right of diagram to aid in projecting horizontals. Time throughout means "apparent local time"; to reduce to "mean local time" add "equation of time" from Ephemeris. To obtain standard time add to mean local time 4 min. for every degree that the observer is west of the standard meridian.

The latitude *L* is usually obtained from an accurate map. Scaling off in the field the latitude from a map, then looking up its functions, is inconvenient and frequently causes errors. To obviate this, draw on the most convenient map of the field of survey a number of parallels of latitude, preferably equidistant, ½ or 1 in. apart, and on these parallels write out, before starting on the survey, the functions, sine and cosine, of the latitudes. Fig. 7 shows an outline of a township so labeled.

Thus, for a point ¼ mile north of the corner of sec-

TABLE I. SINE OF SUN'S DECLINATION AT NOON IN LONGITUDE 120° W. OF GREENWICH

Date	Sin d	
Nov. 5	—0.2702	
6	0.2754	
Sun. 7	0.2803	
8	0.2852	
9	0.2900	
10	0.2948	
11	0.2994	
12	0.3040	
13	0.3085	
Sun. 14	0.3129	
15	0.3171	
16	0.3213	
17	0.3254	
18	0.3294	
19	0.3333	Add 2 in 4th place for each hour p.m
20	0.3371	

TABLE II. ERROR IN AZIMUTH CAUSED BY 1′ OF ERROR IN DECLINATION OR LATITUDE FOR VARIOUS LATITUDES AND TIMES

$\frac{dZ}{dd} = -\sec L \ . \ \csc t$ $\qquad$ $\frac{dZ}{dL} = \sec L \ . \ \cos t$

Time		When Decl. increases 1′ in a.m., azimuth increases am't. shown; in p.m. decreases			When Lat. increases 1′ in a.m azimuth decreases am't shown; in p.m. increases		
a.m.	p.m.	L=30°	L=40°	L=50°	L=30°	L=40°	L=50°
11:30	12:30	8.89	10.00	11.95	8.78	9.95	11.82
11:00	1:00	4.47	5.05	6.00	4.31	4.88	5.80
10:30	1:30	3.03	3.43	4.07	2.78	3.16	3.76
10	2	2.31	2.61	3.11	2.00	2.26	2.69
9	3	1.63	1.84	2.19	1.15	1.31	1.56
8	4	1.33	1.51	1.80	0.67	0.75	0.90
7	5	1.20	1.36	1.62	0.31	0.35	0.42
6	6	1.15	1.31	1.56	0.00	0.00	0.00

tions 14, 15, 22 and 23, the logarithmic sine is 9.75041. With the aid of such a map it would require gross carelessness to obtain wrong values of these functions. If there is no sufficiently accurate map of the vicinity, or if the topography or local names on it are too meager to identify the observing station, then the sun's altitude at noon will give the observer's latitude which, once obtained, may be carried a long distance, until another observation for latitude can be conveniently made. The

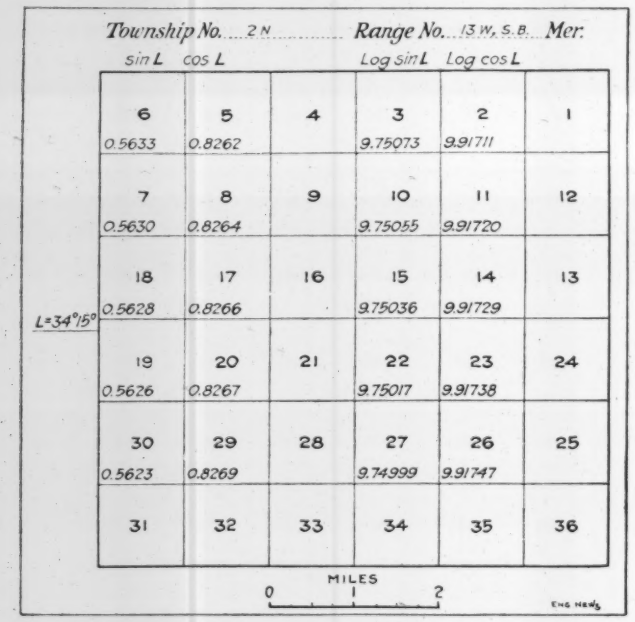

FIG. 7. TOWNSHIP MAP PREPARED FOR FIELD COMPUTATIONS

error in azimuth caused by 1′ of error in latitude is given by the equation

$$\frac{dZ}{dL} = sec\ L\ .\ cos\ t \qquad (5)$$

Table III gives numerical values for a few typically

TABLE III. REFRACTION CORRECTION

Altitude = h =	10°20′	12°30′	16°00′	21°50′	33°40′	63°30′
Refraction = r =	5′	4′	3′	2′	1′	

selected arguments. This table shows that in general the accuracy of the latitude should be about equal to that desired in the azimuth.

FIELD WORK—The altitude h of the sun is the quantity measured. Its reading must be corrected for the zero error of the vertical arc and for refraction. Refraction makes all objects in the sky appear too high; the correction is therefore *always* negative. Nearly all handbooks of the ephemeris contain certain refraction tables varying for various times of the year, and for the hour of observation, with certain coefficients for latitude and plus or minus in sign. The mistake is customarily made by engineers, and in many textbooks, of applying these refractions to direct solar observations additively or subtractively. Both the magnitude and sign of these corrections are wholly inapplicable to direct solar observations, but are intended for use with solar attachments *only*. Refraction proper is a function of the altitude only, and is expressed by the equation.

$$r' = cot\ h \qquad (6)$$

or more accurately

$$r'' = 58\ cot\ h \qquad (7)$$

where

r'' = Refraction in seconds of arc;
r' = Refraction in minutes of arc;
h = Altitude of object observed.

The refraction correction need not be more than twice as accurate as the reading of the altitude; 0.5′ being usually sufficient, the value of *cot h* need be obtained to one decimal place only. For this purpose Table III will be found useful.

The law of refraction expressed by equations (6) and (7) holds true for altitudes higher than 10° or 15°; below these altitudes the law is unreliable, the variation being rather irregular. No observation should therefore be made when the sun is lower than 10° or 15° in altitude, or, in general, when the refraction, as found by the above equation, is more than 3 to 4 times as great as the accuracy of the altitude reading. Also, near the noon hour the sun's altitude changes very slowly in comparison with its change in azimuth, so that a very small inaccuracy in reading the altitude will produce an error many times as great in the computed azimuth. No observation should therefore be made within at least 1½ hr. before or after noon.

The observation proper consists in obtaining accurate simultaneous readings of the altitude and line azimuth of the sun. Many of the personal, and all of the instrumental errors occur in these readings. The following procedure has proven itself, in the writer's experience, to be quite error-proof:

(1) Make observations twice a day, during the middle of the forenoon and afternoon; the lower the sun the better, until about 15° of altitude.

	READINGS OF		COMPUTED VALUES OF			
	h_r = alt.	Z_L = LINE az.	h = TRUE alt.	dZ/dh = RATIO OF INCREMENTS	Z = COMPUTED AZIMUTH	Z_L − Z
1	22° 12′	284° 37′	20° 57′		284° 46′	9′
		11	18	0.61		
2	21° 54′	284° 48′	20° 39′		284° 57′	9′
		10	15	0.67		
3	21° 39′	284° 58′	20° 24′		285° 05′	9′
		19	25	0.76		
4	18° 50′	105° 17′	19° 59′	X	105° 22′	9′
		10	22	0.45		
5	18° 28′	105° 27′	19° 37′		105° 35′	8′
		10	17	0.59		
6	18° 11′	105° 37′	19° 20′		105° 45′	8′
Total and Averages	60		97	0.62	5)	41
					Z_L is to small by	8′

NOTE: The difference between h_r and h in cols. 2 and 4 is the index error of the vertical circle, and refraction which was, in this case = 1°12′3″. The telescope was plunged between 3rd and 4th readings, hence, the difference in sign of index error, and 180° in azimuth.

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FIG. 8. SAMPLE FIELD NOTES OF SET OF OBSERVATIONS

(2) Level the transit, setting one pair of leveling screws in the direction of the sun; orient on the back azimuth, else set or assume one.

(3) Find the sun approximately, over the telescope tube, then take its image on a white piece of paper held 3 to 5 in. in front of the eye-piece; adjust the focus of the eye-piece, the crosshairs, and the distance of the paper so that the image of both the sun and the crosshairs will appear sharp.

(4) While holding the paper with one hand, manipulate with the other hand the tangent screws of the horizontal and vertical verniers, until the sun is bisected both ways. If an assistant is available for holding the paper,

so much the better. Be sure that the horizontal bisecting hair is the middle one. The bisection is made by estimation.

(5) When the bisection appears to be exact both ways, remove the paper, and read the horizontal and vertical verniers; record as in Fig. 8. If you have a watch, note the time.

(6) As soon as the first set of readings has been recorded, replace the paper in front of the telescope. The sun's image will still be within the field of view, but displaced from its symmetrical position about the cross-hairs, both in altitude and azimuth, by from 10′ to 20′ of arc. Manipulate the tangent screws again, until another bisection is made. Read and record again.

(7) Repeat this bisection, taking six readings in all. If the adjustments of the transit are in doubt, plunge and reverse the telescope after the third reading. Record all readings, as in Fig. 8, and particularly the differences between the successive readings of h and Z, also the ratios of these differences, as shown in columns 3, 4 and 5.

The ratios of the increments tabulated in column 5 of Fig. 8 represent the change in azimuth caused by 1′ of change in altitude. Without computing a single observation, these ratios pierce through the haze of mathematical, instrumental and personal errors, and tell the observer, while he is in the very act of observing, how accurate each set of readings is, which to discard, how many to take, at what altitude to observe, etc. Thus a critical examination of these ratios in Fig. 8 will show that:

(1) Since the rate of change of the sun's azimuth during the 5 min. of time occupied by the observation is practically constant, then if the measurements of h and Z were perfect these ratios would be equal; their inequality is due to instrumental and personal errors. The mean ratio, 0.62, depending as it does on a larger interval, is probably more accurate than any other individual ratio; therefore, the third and fourth ratios, tabulated as 0.76 and 0.45, are most likely incorrect. The inaccurate readings which caused these unbalanced ratios must lie in the fourth observation, since all the other readings have been used in obtaining the other ratios, which appear to agree within reasonable limits. The fourth observation should, therefore, be discarded, and not computed; but in Fig. 8 it has been computed for the purpose of showing the effect in the last column of corrections.

(2) These ratios need not agree with each other, for ordinary work, closer than within 5% or even 10%, that is, to an accuracy of between 1 and 2 significant figures. These are, therefore, best computed mentally, at the instant of recording each reading, and only to 2 or even 1 significant figure. With a little experience the observer will be able to analyze the accuracy and reliability of each reading at the instant that he writes down these ratios. Should any reading prove unreliable, omit it and take another in its place.

(3) The exact meaning of the variation of these ratios may be analyzed as follows: These observations were made with an instrument whose graduations were such that the vertical angles were in doubt by 40″, and the horizontal angles by 30″. Consider the difference between the second and third readings of Z, tabulated as 10′. Since each of them may be in error by 30″, the probable combined error is, by the method of least squares, $30\sqrt{2} = 42'' = 0.7'$, which is the probable error in the difference 10′. The probable percentage error in the difference is $0.7 \div 10 \times 100 = 7\%$. Likewise the probable error in the recorded difference of 15′ in the altitudes is $40\sqrt{2} = 57'' = 0.95'$. And the percentage error is $0.95 \div 15 \times 100 = 6.3\%$. The probable combined percentage error in the ratio tabulated as 0.67 is $\sqrt{7^2 + 6.3^2} = 9.4\%$, showing that a discrepancy of $67 \times 0.94 = 0.06$, between the various values of the ratios is permissible. Conversely, a given difference of 0.06 between the mean ratio and any individual ratio shows that the readings producing this ratio are probably accurate within the possibility of this transit. This analysis, while unnecessary in practice, will aid the reader in grasping the usefulness of these ratios. By a little study he will easily extend this analysis for further deductions.

(4) After the six readings have been obtained, it is necessary to compute only two observations, the first and last. The intermediate values of Z being proportioned according to the computed mean ratio. Thus, the computed Z of second observation equals the computed azimuth of the first observation + increment in $h \times$ mean ratio $= 284° 46' + 18' \times 0.62 = 284° 57'$.

It is the writer's practice, however, to compute all six observations, by the slide-rule. By systematic tabulation, as shown in Table IV, the computation is made in about five minutes, and the accuracy of the final average is within 1′ of arc, though some of the individual results may be 1′ or even 2′ in error, owing to slide-rule work.

In Table IV, columns 1 to 5 are identical with those in Fig. 8; the natural *sin h* and *cos h* in columns 6 and 7 are selected at one time. Under column 6 of *sin h* is entered the *sin L*. 0.5636 in this case, taken from Fig. 7, or otherwise. This is the constant multiplier for the various values of *sin h*, in order to obtain *sin h . sin L* in column 8. This multiplication is done by a slide-rule. For this particular table a 10-in. rule was used. Under column 8 is entered *sin d*, taken from Table I, or from the ephemeris. The difference between *sin d* and each of the values of *sin h . sin L*, obtained mentally, gives the numerator of equation (3), in column 9. Likewise *cos L* which is 0.8260, entered under column 7, forms the con-

TABLE IV. FINAL RESULTS COMPUTED WITH A 10-IN. SLIDE RULE

1	2	3	4	5	6	7	8	9	10	11	12	13
	hr	h	Z_L	dh/dh	sin h	cos h	sin h . sin L	Num.	cos h . cos L	cos Z	Z	e
1	22°12′	20°57′	284°37′		0.3576	0.9339	0.2015	0.1965	0.771	0.255	284°46′	9′
		18	11	0.61								
2	21°54′	20°39′	284°48′		0.3527	0.9358	0.1988	0.1992	0.773	0.258	284°57′	9′
		15	10	0.67								
3	21°39′	20°24′	284°58′		0.3486	0.9373	0.1965	0.2015	0.774	0.2603	285°05′	7′
		25	19	0.76								
4	18°50′	19°59′	105°17′		0.3417	0.9398	0.1924	0.2056	0.776	0.265	105°22′	x 5
		22	10	0.45								
5	18°28′	19°37′	105°27′		0.3357	0.9420	0.1890	0.2090	0.778	0.2687	105°35′	8
		17	10	0.59								
6	18°11′	19°20′	105°37′		0.3311	0.9436	0.1865	0.2115	0.779	0.2713	105°45′	8
		97	60	0.62	0.5636	0.8260	0.3980				61	5) 41
							Z_L is too small by					8′

stant multiplier for obtaining *cos h . cos L* in column 10. Column 9 divided by column 10, gives column 11.

A still further simplification of the solution of equation (3) may be made by writing it in the form

$$cos\ Z = (C - A)\ B \qquad (8)$$

where

$C = sin\ d.$

$A = sin\ h\ .\ sin\ L.$

$B = sec\ h\ .\ sec\ L.$

A table is made for A and B, using for L the mean latitude of the survey; so that h, the altitude, is the only variable; C is taken from Table I. After computing Z, it may be corrected for the exact value of L by Table II. By this method the whole computation resolves itself to one subtraction and one four-place multiplication. The reader will easily work out the details of this last table, and a tabular form similar to that of Table IV.

SUMMARY—By avoiding the use of all attachments "the intricacies of the method" are reduced to bisecting the image of the sun, and reading the vertical and horizontal angles. A diagram similar to Fig. 7 and Tables I and III are essential. As many of the other tables and figures given as are found useful may be prepared by the observer before starting for the field. Instrumental and personal errors and mistakes are detected and adjusted by inspecting the ratios of the successive increments—the computation is reduced to a solution of equation (3), most of the factors being taken directly from special tables, without any chance for error, while the slide-rule checks any possible errors in computation. The usual time occupied is five minutes in taking the readings and five minutes in figuring, all of which may be done while waiting for the rodman. The accuracy obtainable is about one-half of the least transit reading, down to one-half minute. We therefore have in this an easy, certain and accurate method of obtaining the azimuth by direct solar observation.

❖

A Locomotive Boiler Explosion on the Detroit & Toledo Shore Line R.R., at West Detroit, Mich., on Jan. 5, has been investigated by the Locomotive Boiler Inspection Division of the Interstate Commerce Commission. The following details of the accident are taken from the report of the chief inspector.

Locomotive No. 2 was built by the Baldwin Locomotive Works in 1904. The boiler was of the extended wagon top type with radial stay firebox. The working steam pressure was 200 lb. per sq.in. On its last trip prior to the accident the locomotive was twice held up by derailments and eventually its supply of water gave out and it had to be towed to a point where this supply could be renewed. On this trip the engineer first noticed improper action of the water gages. The explosion was caused by the dropping of the crown sheet, while the locomotive was standing at the West Detroit terminal.

An examination of the boiler showed that, due to low water, the crown sheet had been overheated. It was blown down 19 in., pulling away from 343 radial stays. The door sheet was pulled over across the top and the right side sheet was also pulled over along the top for a length of about 6 ft. The color of the crown sheet showed that the metal had been overheated to a point 2½ in. below its highest part. Forty-four radial stays were found to have been broken prior to the accident. Thirty-five of these stays were in the portion of the sheet which was blown down. An examination of the bottom water glass cock showed that it was filled with scale, preventing the water glass from indicating the level of the water in the boiler.

The locomotive was equipped with three 3½-in. muffled safety valves. These valves were removed and tested under steam pressure on another locomotive. One valve opened at 185 lb., the second opened at 195 lb. and the third valve failed to open at 235 lb.

The company's boiler inspector certified that he set the three safety valves on Oct. 7, 1912, at 200 lb., 205 lb. and 205 lb., respectively. The same inspector inspected the boiler on Dec. 3, 1912, and certified that the staybolts and crown stays were in "good" condition. Since 44 of the radial stays were broken prior to the accident it is probable that this inspector either did not inspect the stays or he was not a competent inspector.

This accident was caused by the overheating of the crown sheet, due to low water, but it is probable that the accident would never have occurred had the water glass been maintained in a satisfactory condition.

Safety on Railroads

By J. W. Coon†

The great majority of American railroads are making a serious study of the Safety problem. The Baltimore & Ohio was the first Eastern road, so far as I know, to form committees affecting each branch of the service. We have been actively engaged in this work for a year and a half.

Everyone who has studied the question of preserving human life on railroads will agree that there are ample rules and instructions in effect and that they are clearly drawn. It is impossible to correct present evils simply by securing greater alertness on the part of the officers or by originating additional rules. The great majority of railroad men are careful and competent. The mistakes are made by the few, but we must work with all, for we do not know the few who will cause the trouble; it, therefore, resolves itself into getting the employees interested. With this in mind on November 1, 1911, we appointed a General Safety Committee and Divisional Committees.

Each Divisional Committee is made up as follows: Shopman. Engineer or fireman. Conductor or brakeman. Yardman. Agent. Supervisor or assistant division engineer. Medical Examiner. Division Claim Agent.

Half the divisional committee is changed every six months.

Reports are made by these committeemen weekly to the officer to whom they report, copy being sent the General Committee. The suggestions are tabulated by the General Committee, and every one is followed up.

The members of the General Committee endeavor, also, to attend at least three divisional meetings each month. They go over the division in daylight, the local members accompanying them and pointing out what work has been recommended and how much of it has been done.

We have covered over 1500 machines in the shops. We have put walkways on many bridges, especially where located near switches; moved buildings and poles back to give clearances; raised the hand railing on caboose cars as men have been jerked over the low ones, etc.; all at the suggestion of the men. The men will take about the same interest they see the company taking.

CAUSE OF FATAL INJURIES—We found, in carefully analyzing the fatal injuries to employees during the past year, that over 90% were due to cause that no expenditure of money in providing additional safeguards, etc., could possibly have prevented. They were due to failure of the human element. I do not say they resulted from carelessness; some were due to thoughtlessness, some to lack of familiarity with the movements and some to carelessness, even though possibly this was caused by over zealousness on the part of the employee in trying to do the work in too much haste.

The point I want to make perfectly clear is that the great majority of fatal injuries to employees on the railroad are due to causes the railroads cannot, in any possible way, by the expenditure of money, correct. Yet we often read articles that would lead the general public to believe that the large majority of injuries were due to the fact that railroads would not provide this or that safety device, did not maintain their track or equipment properly, etc. Some accidents ARE due to those causes, but bear in mind that 90% are NOT.

The only possible way the 90% can be reduced is to stimulate, in some manner, greater vigilance and care.

Let me make plain in what way the injuries comprising the 90% are occurring; 17 employees, during the past year, were fatally injured by stepping off one track on to another, to let a train pass, the noise of the passing train drowning the sound of the train coming in the opposite direction. Our rules require employees to step clear of all running tracks.

Ten cases were chargeable to adjusting coupler, angle cock or air hose while cars were in motion. This is strictly against the rules and in addition President Willard, in his talk before the employees at Baltimore a year ago stated: "I want to discourage the idea that you are expected, by the officers of this Company, to do anything that is not safe in performing the work that you are expected to do."

Thirty-five employees were struck by trains. Some were walking in the yard or on the track not paying proper attention. Some were working on the track, often with caps pulled down over their ears, not keeping a lookout. We have automatic bell ringers on most of our engines and the rules require the use of both bell and whistle where men are liable to be working. Two of the men struck were asleep

*Extracts from a paper read before the New York Railroad Club, Feb. 21.

†Assistant to General Manager B. & O. R.R., Baltimore, Md.

on the track; one had been sent back to flag and protect a train; 6 fell in jumping on or off moving trains; 4 were riding the pilot of engine when either the pilot caught on something and turned under or the man jumped off between rails and fell. Strict rules are in effect against riding on pilots.

TRAIN ACCIDENTS—We now come to fatal injuries in train accidents. Please bear in mind that only 19% of all employees fatally injured in the past year were in train accidents, and this includes all the minor accidents, such as cars sidewiped in the yards, striking cars too hard, etc. Additional safety devices would not have helped the 80% in the least.

Thirty employees were fatally injured in train accidents. Please note carefully that 25 out of the 30 resulted from failure of the human element in the manner that I will illustrate by a few instances. Five of the thirty were from unavoidable causes, or from those which might be chargeable to the Company. They included such accidents as ice forming on rail, causing car to leave track.

Let me illustrate, by a few instances, some of the accidents chargeable to failure of the human element:

The first is a head-end collision in which three employees lost their lives. It was the practice of the front brakeman, who was riding on the engine, to wave at his girl in passing. On that date the train had a meeting point at this station. The girl was not on the porch, as usual, and the brakeman asked the engineer to whistle for her. Being engaged in this way and laughing and fooling together, they overlooked the fact that they had a meeting point.

After another accident, it developed that our rule providing that all train orders must be shown the fireman and brakeman, so that all would be fully informed, was disregarded. The engineer on the second engine (this being a double-header) left it to the leading engineer, who frankly admitted that he overlooked the order. The order had not been handed to the fireman or brakeman. The conductor did not check up the engineer. In other words, our rules provide a check on each man, or in this case, seven checks on the leading engineer, yet through the disobedience of a rule that is clearly understood three men paid the penalty.

Popular writers often make the statement that railroads promulgate this or that order, make Safety talks, etc., merely to blind the eyes of the public as to the actual cause of the accidents, and then issue instructions that require the men to make time regardless of weather or other conditions, or hurry them in their work so that they are not permitted to be careful. Possibly in some minor cases this is true, but in the great majority of cases it is not.

If a device were brought forth that would prevent the majority of the fatal injuries, even though it were expensive to install, there is not a railroad Executive who would hesitate one second to capitalize his personal injury expense at 5% and borrow sufficient money to install the device. But he realizes, as the public often does not, that safety devices will not do this. Employees are not meeting with fatal injuries from lack of safety devices and, in fact, very few passengers are. For, as shown, over 80% of all fatal injuries to employees in train accidents are caused by some failure of the human element.

Further in the matter of hurrying the men, let me again quote from President Willard:

> So far as I represent the management, I want the men to feel that in the matter of their line of work they are to take the time to do it as safely as possible. In passenger service, above everything else, is the safety of the train; second, comfort; third, punctuality.

You will note that speed is placed last. It is sometimes said that men have to run by signals, on rainy or foggy nights, without being sure of their position. Otherwise they would be taken off the preferred run or, at least, criticized. I have been in the operating department of this road for 25 years, and have never yet known of an engineer being censured where he could not make time because of fog or extremely stormy weather. Often a messtage is sent the engineer asking the cause of the delay. Some might consider this as a criticism. It is not. It is necessary to make report of every delay and it is to enable a local officer to do this that the message is sent.

The officers of this company believe in frankness and have directed the Safety Committee to analyze the train accidents and call the attention of employees to any special lesson regardless of whether the company is at fault or it was due to failure of the human element. The lesson is what we are after. We therefore, tell the employees, each month, in our magazine that is issued free to all, exactly how the accidents occur.

We also analyze the personal injuries and inform the employees exactly how they happen. We post on bulletin boards over the entire six thousand miles of road, within two or three days of its occurrence, the cause of any fatal injury and caution our men to avoid a similar accident. The monthly employees' magazine, already referred to, is read by our sixty thousand employees, and, in this way and the Bulletins, we keep the question of Safety constantly before them.

NIGHT MEETINGS—In addition to this we hold, each month, at some point on the line a night meeting, to which all employees and their families are invited. We tell them plainly what we are trying to accomplish and how.

MAKING OBSERVATION TESTS—We also carry on observation tests—sometimes improperly called "surprise tests." Each division is required to make not less than a given number of tests. For example, a clearance card is made to show the wrong engine number or incorrect date to see if the crew are alert and detect these errors. A train order is improperly repeated to see if the dispatcher or operator is vigilant. A signal light is removed or a signal improperly displayed to see if the rules requiring train to stop under those circumstances are observed. These are not "surprise" tests; they are limited to conditions met with every day and no "catch" features are permitted or anything that endangers life or limb, but they enable one to locate the careless man BEFORE an accident occurs.

These tests should be diversified—should be made with every employee in train service and a careful record should be kept. If an engineer fails, he should be given another test of a different nature and this followed up to see if he profited by the lesson. If habitually careless he should not remain in train service. The value of these tests cannot be overestimated.

NOT A PASSENGER KILLED IN FIVE YEARS—It is most gratifying to turn, in closing, to the fact that for five years on the Baltimore & Ohio R.R. we have not killed a single passenger in a train accident, and during that time we have carried eighty-five million, or almost as many souls as there are in the United States. This speaks volumes for the good work done by the employees in caring for the passengers entrusted to them. We want them to be equally careful in their shop, yard or track work, where passengers are not involved, but where their own lives and limbs are at stake.

❖

A Forum for Electrical Inventions is proposed as part of the activities of the New York Electrical Society for the coming year, by the newly elected president, Henry L. Doherty. The scope of the plan is indicated in a recent circular letter, sent out by the secretary, George H. Guy, part of which reads as follows:

> The simple plan that will be tried out at first is, to invite all manufacturers and inventors having meritorious inventions to submit them to the members for inspection at the regular meetings, without interfering with the set program. The idea is that the apparatus can be set up in one corner of the meeting room and there exhibited and explained to the members before and after the meetings, and if there should be sufficient time, someone representing the apparatus would be invited to open a discussion on the subject.
>
> It is thought that in this way, month by month, the new apparatus will be successfully brought to attention and all members will have an opportunity to become better posted as to what is doing, not only in their own branch of the industry but in others outside, in which they naturally have an intelligent interest.

Terminal Coaling Stations on the Panama Canal will be located at Cristobal and Balboa. At the former place, the Atlantic entrance, a plant capable of loading 2000 tons or unloading 1000 tons per hr., will be built and a smaller plant capable of loading 1000 tons or unloading 500 tons per hr. will be constructed at Balboa, the Pacific entrance. The storage capacity of the Cristobal station will be about 290,000 tons and the station at Balboa will be able to accommodate 160,000 tons.

Specifications for the machinery at the two plants have been drawn up and bids will be requested shortly. These specifications call for crane equipment for loading and unloading operations and for a conveyor system for handling the coal between the cranes and the storage bins.. It is planned to have the Government build the substructure or storage bins (which are to be of reinforced concrete), while the coal-handling machinery will be supplied by the successful bidder.

A feature of these two stations, which is somewhat out of the ordinary, is that vessels will not go alongside the wharves to receive coal, but will be loaded while lying out in the stream, from barges working in conjunction with the machinery on the dock. However, the plants will be capable of loading vessels alongside the wharves if that method is found expedient. The innovation is planned for greater convenience and economy of time.

The above information is taken from the "Canal Record" of Jan. 29.

Hardpan and Other Soil Tests.

By J. Norman Jensen*

During the present year, various architects and engineers of Chicago, in coöperation with the Building Department of the city, conducted tests to ascertain the safe load which might be placed on the soil at considerable depths below the surface of the ground. The particular soil under investigation was that commonly called "hardpan." It was found that the term "hardpan" had

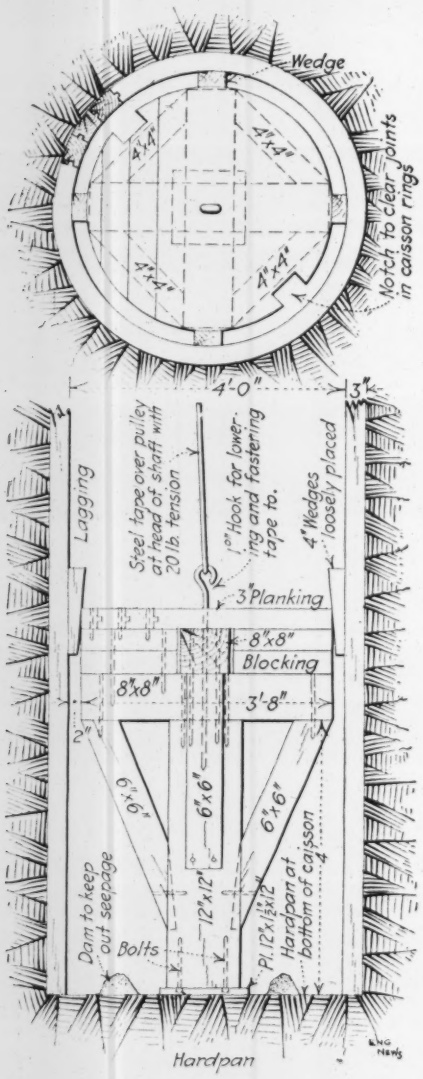

Fig. 1. Plan and Elevation of the Loading Platform Used in Measuring the Bearing Values of Soils

different meanings to different men, some designating by that term a tough surface clay, while others only considered as being true hardpan a soil almost as hard as rock, located at depths from 60 to 100 ft. from the surface of the ground. There was also a considerable difference of opinion as to what could be considered a safe load on this very hard soil, the values used varying from 8000 to 15,000 lb. per sq.ft. It was known that various buildings in the city rested on hardpan, and the dead load of these buildings could be computed with a reasonable degree of accuracy, but there was always uncertainty as to the actual live load on the floors of any one building at any time, so that the actual load on the soil was only approximately known.

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The foundation proposition always has been and still is a troublesome question in Chicago. Most of the business district is on an old swamp or on "made" land. For this reason the ingenuity of architects and engineers has been brought to a test, and several types of foundations have been originated to meet the conditions found. Some of these types have been inadequate, and have proved a continual source of expense to the owners of some of the large office buildings. Others, such as the caisson type, have been evolved and seem to be the solution of the problem. In the heart of the business district these caissons usually extend to rock about 100 ft. from the surface. Where there is no danger that the adjoining property owners will ever go beneath the bottom of the caisson, these caissons occasionally rest on hardpan.

In investigating the safe load which might be placed on hardpan, it was desirable that the loading platform should be placed at the bottom of the caisson. It would be impracticable to have the load at the top of the caisson, because of the extremely long post which would be necessary. If such a long post were used, there would always be uncertainty as to whether the recorded settlement of the load represented an actual settlement or only the bending of the post.

A plan and elevation of the loading platform are shown in Fig. 1, and Fig. 2 shows a view of the device as actually used in the tests. It was 3 ft. 8 in. in diameter, 5 ft. high, and had in its center a 12x12-in. post, shod with a 12x12-in. steel plate, 1½ in. thick. Notches were cut in the 3-in. planking of the platform, so that the platform could be lowered past the lugs of the caisson rings.

Description of Hardpan—In the first three tests the soil was a true hardpan. It may be defined as a very hard, dry, blue clay, mixed with small pebbles. This clay was so hard that a scratch could not be made upon it with the finger nail, nor would a lump be crushed under the weight of a man. It was necessary for a good stout digger to swing a drub or miner's pick with considerable force in order to drive it into the hardpan ½ in.

Test No. 1—The first test of the series was conducted on the site of the new Cook County Hospital at Chicago. A caisson was selected which was not particularly favorable for the test, as it was adjoining an old building foun-

Fig. 2. Side View of the Loading Platform, Showing Comparative Size and Construction

dation, and there was danger that the lagging of the caisson might cave in. There was also considerable seepage from a sewer pipe which had been broken in sinking the well. At the conclusion of the test there was about 12 ft. of water at the bottom of the shaft.

The caisson selected was 4 ft. 3 in. in diameter, 65 ft. below the surface of the ground, and 51 ft. below City Datum. The hardpan was about 15 ft. thick. The platform was lowered into place and wedges driven loosely between the platform and the lagging. This was done so as to steady the platform while loading. Pig iron was placed on the platform, and readings of the settlement taken at intervals. A steel tape was stretched from a fixed point on the platform, and the tape read at a fixed point at the top of the caisson.

Load	Time	Reading
4,100 lb.	Jan. 26, 12 p.m.	52 ft. 4 11/16 in.
10,900 lb.	Jan. 27, 6 a.m.	52 ft. 4 11/16 in.
24,200 lb.	Jan. 27, 1 p.m.	52 ft. 11/16 in.
24,200 lb.	Jan. 29, 9 a.m.	52 ft. 5 1/16 in.

From the above table, it is seen that the settlement was 3/16 in. in 44 hr. when the soil was loaded to 24,200 lb. per sq.ft. The test was under the supervision of Morey, Newgard & Co., engineers for the new Cook County Hospital.

TEST NO. 2—The hardpan under the Marshall Field Estate Building, at the corner of Wabash Ave. and South Water St., was tested in a similar manner. A steel tape was attached to a hook in the middle of the loading platform, and hung over a pulley above the center of the caisson. Weights were attached to the tape so as to maintain a constant pull. A bench mark was established, and readings with an engineer's level taken directly on the steel tape. The hardpan tested was 66 ft. below City City Datum. Throughout the test the well was dry as a bone.

Load	Time	Reading
10,600 lb.	June 5, 5 p.m.	70 ft. 6 in.
24,200 lb.	June 7, 6 p.m.	70 ft. 6 in.
24,200 lb.	June 10, 10 a.m.	70 ft. 6 7/16 in.

It will be noticed that there was no settlement until the full test load of 24,200 lb. per sq.ft. was applied. After the full load had been on for 64 hr., a total settlement of 7/16 in. was obtained. George L. Harvey was architect of the Marshall Field Estate Building, and supervised the test.

TEST NO. 3—It was known that the hardpan under the Butler Building, on Randolph, Canal and Lake Sts., was of exceptional hardness, so a greater load was put on the soil than in any of the previous tests. A caisson 4 ft. 6 in. in diameter was selected, and the platform lowered to the bottom of the well. A 2x4-in. strip, long enough to project over the top of the pig-iron load, was firmly nailed to the top of the platform. A nail was driven into the top of the strip and another one into a timber in the top of the well. Careful measurements were taken between the two nails. The hardpan tested was 70 ft. below City Datum. Throughout the test the well was absolutely dry.

Load	Time	Reading
2,000 lb.	June 17, 5 a.m.	51 ft. 5 in.
30,000 lb.	June 17, 9 p.m.	51 ft. 5 in.
30,000 lb.	June 20, 9 a.m.	51 ft. 5 3/16 in.

This test, as shown above, gave the highest bearing values, as a load of 30,000 lb. per sq.ft. only settled 3/16 in. in 60 hr. D. H. Burnham & Co. were the architects of the Butler Building, C. I. Hogue was superintendent.

TEST NO. 4—The soil in this case was not, strictly speaking, hardpan, but could be characterized as a stiff blue clay. It contained a small amount of stones, about 1/4 in. in diameter. The clay was moist enough so that a slight impression could be made in it with the soft part of the finger. A good stout digger could only shovel it with persistent effort, and found it necessary to drive the shovel into the clay by stamping it with his boot. No grub was used in any of this work. The soil tested was 10 ft. below City Datum in one of the caissons of the Sears, Roebuck & Co. Building, located on Harvard and Central Park Aves. The measurements of settlement were obtained by means of an engineer's level and a rod held on a long steel rod, babbitted into a hole in the platform. The test was continued for five days.

Load	Time	Reading
3,000 lb.	May 18, 10 a.m.	4 ft. 1 1/16 in.
6,500 lb.	May 18, 11 a.m.	4 ft. 1 3/16 in.
15,200 lb.	May 18, 1 p.m.	4 ft. 1 5/16 in.
24,100 lb.	May 18, 2 p.m.	4 ft. 1 1/16 in.
24,100 lb.	May 19, 10 a.m.	3 ft. 11 1/2 in.
24,100 lb.	May 20, 5 p.m.	3 ft. 11 in.
24,100 lb.	May 21, 3 p.m.	3 ft. 10 1/8 in.
24,100 lb.	May 23, 4 p.m.	3 ft. 9 1/16 in.

As the load seemed to settle indefinitely, test was discontinued. From the data obtained, it seems that the ultimate carrying capacity of the soil in question was reached when the load per square foot was a little more than 15,200 lb. George Nimmons was the architect.

TEST NO. 5—It was thought that the large settlement of the previous test might have been caused by the clay oozing out from beneath the post of the platform, and rising alongside of the post. In order to test the truth

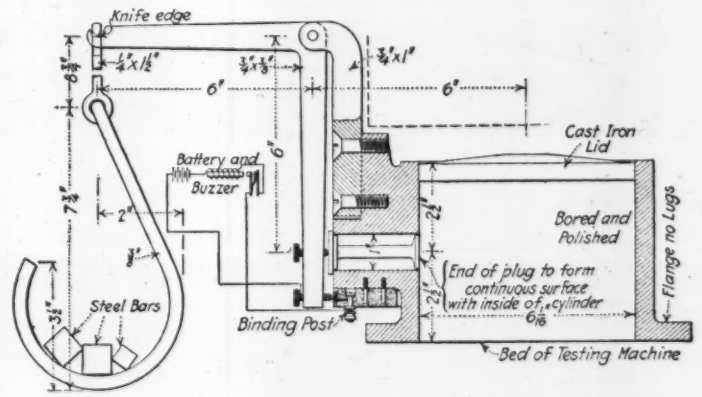

FIG. 3. APPARATUS USED IN LABORATORY TESTS ON BEARING VALUES OF SOILS

of such a theory a test was run on the site of a building located on 22d and Calumet Ave. The soil was a very soft blue clay, 21 ft. below City Datum. A float was arranged alongside the post of the platform to detect any tendency of the soil to rise, when under load. The settlement was obtained by reading the distance between the top of a rod in the platform, and a fixed point in the lagging of the caisson.

Load	Time	Reading
7,700 lb.	June 26, 12 m.	4 ft. 11 1/4 in.
7,700 lb.	June 26, 10 p.m.	5 ft. 1/16 in.
12,100 lb.	June 27, 11 a.m.	5 ft. 1 1/4 in.
17,000 lb.	June 27, 2 p.m.	5 ft. 7 in.
17,000 lb.	June 28, 2 p.m.	5 ft. 9 1/16 in.
17,000 lb.	June 29, 8 a.m.	5 ft. 10 1/16 in.
17,000 lb.	June 30, 8 a.m.	5 ft. 10 1/16 in.

At the conclusion of the test recorded above, the float was examined, but there seemed to be no evidence that the soil adjoining the post had risen at all. N. Max Dunning was the architect for this building and supervised the test.

Some Laboratory Tests on Hardpan and Sand

A sample of the hardpan found in Test No. 1 was sent, for laboratory testing, to O. H. Basquin, Professor of Applied Mechanics at Northwestern University, by Mr. Randall, Chief Engineer of Morey, Newgard & Co. Through the courtesy of Prof. Basquin the writer is enabled to give the following information.

A section of the test cylinder used is shown in Fig. 3. It consists of a cast-iron cylinder with an area of $\frac{1}{5}$ sq.ft. On the side of the cylinder is a steel plug of 1 in. diameter. This plug is held in place by means of a bent lever, at the end of which is hung a stirrup carrying a number of steel bars. The lower end of the bent lever is in the circuit of an electric buzzer when the end of the plug is flush with the inside face of the cylinder. The weight of the stirrup and the smaller bar is such that it is equivalent to a load of 1000 lb. per sq.ft. on the plug. Placing an additional large bar in the stirrup means the addition of 1000 lb. per sq.ft. on the plug.

The method of procedure of the test was as follows: The apparatus was placed on the bed of the testing machine, and the cylinder filled with the soil to be tested. The lid was then placed on the cylinder, and the head of the testing machine brought down to a careful bearing on the lid. The circuit of the buzzer was closed, and the load applied. When the sound of the buzzer ceased, a reading was taken on the balance arm of the testing machine. Another bar was then placed in the stirrup, and the experiment continued until the buzzer again became quiet.

The hardpan sample from Test 1 was cut to the diameter of the cylinder and readings taken as outlined above. The data were as follows:

Lateral pressure lb. per sq.ft.	Vertical pressure lb. per sq.ft.	Ratio vertical to lateral pressure
2000	11,600	5.58
4000	16,000	4.00
6000	21,700	3.62
7000	23,700	3.39

Other information obtained was that the tensile strength of the hardpan was 5100 lb. per sq.ft. A briquette was cut roughly to the standard shape of a cement briquette, and pulled apart in the usual manner. The cohesion was found to have a value of 4000 lb. per sq.ft. The angle of internal friction was determined to be 25°.

The same test was made on bank sand found on the shore of the campus of the university. This was not a sharp sand, but had small rounded grains. It was typical of the sand upon which a great many small buildings near the lake shore of Chicago are built. The record of the test reads as follows:

Lateral pressure lb. per sq.ft.	Vertical pressure lb. per sq.ft.	Ratio vertical to lateral pressure
2,000	5,500	2.75
4,000	12,100	3.02
6,000	18,200	3.03
8,000	23,200	2.90
10,000	32,100	3.21

There was no cohesion in this material. The angle of internal friction was found to be 30°. It will be noticed that the ratio between the vertical pressure and the lateral pressure runs more uniform than in the hardpan test.

Relative Bearing Power of Small and Large Areas

The question arises in the design of foundations as to the relative bearing power of small areas compared with large areas. The same unit value is usually used, although there may be considerable variation in area in the individual footings. Is the soil resistance of a large area per unit of area greater than a small area, or *vice-versa?* This was the question in the mind of William Artingsall, Chief of Subway Engineers of Chicago, in the underpinning of the Van Buren St. railway tunnel of the Chicago Union Traction Co., about six years ago, at which time he was Principal Assistant Engineer of the above company. To settle this point, a series of tests was made, and the writer is indebted to Mr. Artingsall for the following information in regard to those tests.

A section of the tunnel is shown in Fig. 4. It was intended to place a new footing under the old wall, but in excavating for the new footing, it was found that some of the piles used in the construction of the old tunnel greatly interfered with the proposed footing. It was advisable to cut down the width of the new footing from that shown on the original design, but still be within safe limits. So it was decided to make a test to answer the question given in a preceding paragraph. The soil under

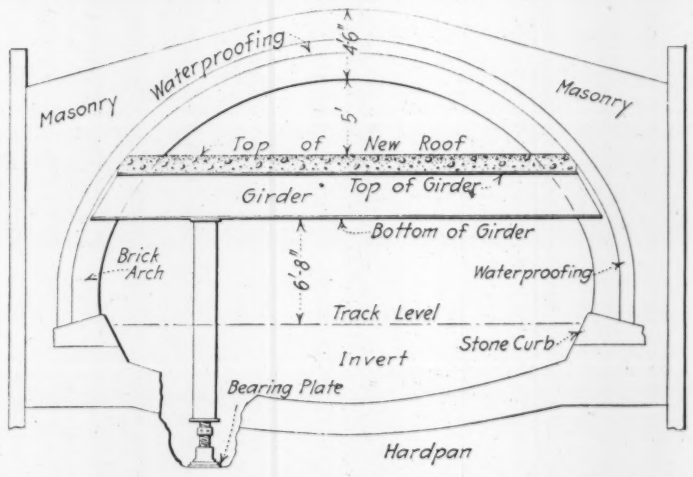

Fig. 4. Cross-section of the Van Buren St. Railway Tunnel, Chicago, Ill., Showing Method of Testing Bearing Values of Soils

investigation was a fairly hard blue clay. It could be grubbed, and yet it was not too hard to dig with a clay knife.

Referring again to Fig. 4, the steel girder shown in the section was in place. A hole was cut in the invert of the old tunnel, and a place leveled off in the clay for the steel bearing plate. On this bearing plate was placed a "drum," extending to the bottom flange of the girder above. The jackscrew was provided with a lever, on which the pull was obtained by means of a block and tackle, operated by a couple of stout laborers. The pull on the lever was registered directly by means of a dynamometer connected to the lever arm.

Several tests were made with bearing plates of different sizes and in different locations, but on the same character of soil. In each case the load that would produce the same settlement was obtained. The results were as follows:

Size of bearing, in.	Load per sq.ft., lb.
4x4	16,000
6x6	24,000
8x8	44,000
8x12	64,000
12x14	98,000

Discussion

From the preceding test, it is seen that there is a marked increase in the soil resistance per unit of area

for a large area compared with a small area. The question naturally arises, then, What should be the standard area for testing soils, at least in field tests? A great many tests have been made on an area 1 ft. square. It seems to the writer that in making tests which are to be compared with other tests, this area should be maintained, just as standard areas are maintained in making steel, cement and other engineering tests.

In the early part of the article mention was made of the fact that some large buildings in congested districts rest on hardpan. Occasionally the material at some depth beneath the hardpan is of a soft or fluid nature. Caissons have been sunk through sand and water, and great quantities of material have been pumped from the surrounding property. There are cases where an old foundation as much as 100 ft. from a new building has been disturbed by the sinking of such caissons. The writer has in mind a case where a street was badly cracked, and had to be repaired because of the material taken in the excavation of a deep caisson. It seems to him that an engineer who puts his building on hardpan instead of going down a few feet further to rock, especially in a city continually changing and growing, is showing a lack of foresight in safeguarding the future interests of the owner of the building.

This movement of the soil under heavily loaded areas is no mere theory. A late prominent engineer of this city who had been identified with the dredging operations of the Chicago River is responsible for the statement that the river bottom rises 2 or 3 ft. every four or five years. This rise is not due to the silting up of the river, as the water is practically pure as it enters the river. It was this engineer's belief that the rise of the river bottom is due to the fact that the river bottom offers the least resistance to the enormous pressure of the large buildings on both sides of the river, and that the soil is squeezed up into the river bottom.

Bearing Power of Soil under Foundations in Chicago*

Tests of the bearing power of the soil underlying Chicago, as related to foundations of buildings, are described in a recent number of the *Journal* of the Western Society of Engineers (Chicago), and with these there is a general discussion on the soil and foundation conditions in that city. From the papers and discussions we have compiled the information given below.

Test of the Bearing Power of Hardpan

A paper by Frank A. Randall† describes a test made for the foundations of the new Cook County Hospital, on the south side of Harrison St., between Wood and Lincoln Sts. This will be an eight-story steel-frame building, 550x70, with four wings 200x40 ft., and will cover a ground area of about 75,000 sq.ft. Bids were received for piles and concrete piers; the latter construction was the cheaper by about $13,000 and was adopted. Preliminary borings were made, 6 in. diameter for 30 ft. and then 3 in. diameter. These showed below the surface fill a bed of yellow clay to about 12 or 15 ft. below the street level, then a soft, sticky clay to about 37 ft. This is followed by solid blue clay, running into hard clay and gravel which extends down to the hardpan at an average depth of 47 ft. below the ground at the south end and 56 ft. at the main building. Two borings showed rock at 67 ft. and 89.5 ft., but the latter was considered the more reliable.

Because of the loads to be carried and the great difference in cost between concrete piers sunk to hardpan and to rock, it was decided to carry the piers (locally termed "caissons") only to the former, provided that the test wells showed a satisfactory bed of hardpan, with rock in the same relative location as in the borings. Four of the wells for the concrete piers were excavated as test wells. Borings were continued down through the hardpan to 85 ft.; and from soundings and borings, rock was found at 90 ft. below ground level. In order that all piers should rest on similar material, the test piers themselves were not carried to rock, but were belled at 85 ft. and 60 ft. below ground surface, the top of hardpan stratum. From the test wells the thickness of hardpan was found to be from 15 ft. to 20 ft., with hard clay beneath.

The test of the bearing power of the hardpan was made at the request of the city Building Department, and was made by means of a vertical post carrying a loading platform. This frame was 5 ft. high, and consisted of a central post 12x12 in., with struts to two 8x8 in. cross timbers at the top, and a deck of 3-in. plank forming a platform 44 in. diameter. The post was shod with a 1½-in. plate 12x12 in., and rested on a 2-in. plate of the same size, laid directly upon the hardpan. Four wedges, loosely driven between the platform and the lining of the well, kept the frame in a vertical position. In the center of the platform was a 2-in. steel rod about 12 ft. long, set in a babbitted hole 14 in. deep. This projected up through the pig-iron load, so that the steel tape attached to its upper end could be removed while handling the pig iron. The measurements were taken from a bench-mark by means of a straight-edge. This device was found to be perfectly accurate when tested by reversal of the carpenters' level, which latter was of more than ordinary sensitiveness and accuracy.

A hole 4 in. deep and about 18 in. square was dug in the center of the bottom of the well, and the 2-in. bearing plate was carefully centered, leveled and bedded. It had been intended to inclose the hole in a wooden box backed with concrete and clay to keep out all water, but as water sprinkled from above directly into the hole this had to be abandoned. The testing frame was raised and dropped onto the bearing plate several times in order to force out as much as possible of the clay which had sloughed into the hole. The pig iron was weighed out in batches averaging about 600 lb., and was lowered and placed as fast as weighed. The pigs were of varying size and were placed in layers of stretchers and headers radiating toward the center, and bonded together in addition by small pieces of wood, as deemed necessary. They were kept at least 1½ in. from the lagging, the pile when completed being about 4 ft. in diameter and a little over 12 ft. high. About 12 tons of pig iron were used. Five readings were taken, with results as follows:

Time	Load, lb.	Total settlement in.
Sat., 12:15 a.m.	4,079	
Sat., 6:30 a.m.	10,887	1/16
Sat., 9:35 a.m.	17,362	1/8
Sat., Noon	23,189	1/4
Mon., 9:00 a.m.	24,200	1/4

*Elsewhere in this issue there is to be found an article by J. Norman Jensen, on this same general subject, and, in connection with the same, views are shown of the soil-testing platform used in the tests for the Cook County Hospital foundations, above mentioned.

†Chief Engineer, Morey Newgard & Co., 56 E. Van Buren St., Chicago.

The piers were designed for a load of 44,000 lb. per sq.ft. at the top and were belled at the bottom to twice the diameter of the shaft. Considering hardpan at 60 ft. below the surface, the unit designing load on the latter is about 13,300 lb. per sq.ft., or about half the test load. The test load was applied to 1 sq.ft., while the area of the well was about 16 sq.ft. It is not known how much the bearing value of the hardpan is increased when the pier is completed and the well is completely filled, but it is thought that it must be a very material increase. The results indicate that the hardpan stratum will carry the designed load with safety. Probably a portion of the settlement was due to the compression of the loose soil which sloughed off as the platform was being lowered. The well stood open ten days after the excavation was completed. No settlement was detected in the footings alongside of the wells.

Test of the Bearing Power of Moist Blue Clay

This test is described by Edwin Hancock,* as follows: Two openings about 8 ft. square were made in the concrete floor of the basement of the Federal Building, and the soil was excavated for a depth of 6 ft., so that there was a bearing on the original clay which had never been disturbed. On this clay a grillage was built up of planks 2x12 in., 2 ft. long, laid closely together so as to give a bearing of 4 sq.ft. This grillage was built up about 1 ft. high, and upon this were placed longer planks to carry the load of pig iron. The settlement was taken by means of a wye level and rod. Readings were taken as soon as each load was put on, and then again after giving an hour for settlement. If no further settlement had occurred, a larger load was placed upon the plank. If the settlement had increased, readings were taken until they showed that the settlement had ceased.

The elevation of the clay was at city datum and about 14 ft. below the street level. The distance between the two testing points was 150 ft. The results of the tests were as follows:

Load lb. per sq.ft.	Settlement, in. Test No. 1	Test No. 2
1000	3/32	1/16
2000	7/64	1/8
3000	1/16	1 3/16
4000	3/32	1 3/4
One hour later (same load)	1/16	1 3/4
Next day (same load)		1 3/4
Two hours later	21/64	..
Four weeks later	5/32	..
Next day	1/16	..

Discussion on Soil and Foundation Conditions in Chicago

Wm. Artingstall—Old plans giving the bearing power of the soil in the downtown district as assumed by different architects and engineers show that some have taken 1½ tons per sq.ft., others 2 tons, and others 1¾ tons. In some cases, an architect has taken 1½ tons, while his neighbor on the next 25-ft. lot has run up to 2½ tons on practically the same character of soil. I say the same soil because all these footings are at about the elevation of city datum. But when you get below datum, it is a question whether the soil is the same on one 25 ft. lot as it is on some other lot.

In underpinning the Van Buren St. tunnel a few years ago we were particularly concerned with the question whether the area of foundation had much, if any, influence on the bearing power of the soil. In other words, if the material was confined, could it sustain a heavier load? Consequently it was necessary to make several tests with increasing bearing areas. We rigged up a device which could be easily handled by two men. This was a drum with the upper end bearing against the bottom flange of a roof girder, and the lower end resting on a bearing plate in contact with the clay. A dynamometer was connected directly to the lever arm, and the block and tackle was fastened so as to obtain a direct pull. The reading on the dynamometer then had to be corrected merely for friction in the jackscrew. The bearing load increased from 8 tons per sq.ft. for a bearing 4x4 in. to 12 tons for 6x6 in., 22 tons for 8x8 in., 32 tons for 8x12 in., and 49 tons for 12x14 in. This proved that we could load our foundations with a much heavier load than we had assumed, and in the river section of the tunnel they are carrying nearly 10 tons per sq.ft. The maximum settlement, shown by levels taken 11 months after completing the work, was only ⅛ in.

F. E. Davidson—I have loaded hard clay to as much as 7500 lb. per sq.ft., and the structure, after five years, shows no unusual settlement. Any foundation constructed on clay will settle. The problem is to so design the building that the settlement will be uniform. There is danger in designing foundations for any important structure, unless provision is made for the re-designing of foundations after the actual excavation has started, to provide for changes in character of soil.

In order to provide for uniform settlement in structures subject to both live and dead loads, the proper distribution of the assumed live loads is as vital and important as the selection of the proper unit stresses. Parts of structures subject to great dead-load stresses will settle more than foundations whose load is largely live load, unless great care is exercised in determining what unit stresses to use in the various cases of loading which occur. There are at least three features of loading in building construction which must be considered in the design of foundation work: 1, the dead weight of the structure; 2, the area upon which there may be live loads; 3, impact loading, such as the vibration of heavy machines, or the impact effect from a large number of elevators. Probably the most difficult problem in connection with building design is to so proportion these loads that the settlement of the structure will be uniform.

J. W. Pearl—The deeper the foundation is placed, the more it will support safely, or the more nearly uniform will be the settlement. I believe the load that may be carried on any given soil is absolutely proportionate to the depth of the foundation, or rather the pressure on the surrounding soil. In any determination of the supporting power of a foundation, the depth of footing and the load applied upon the contiguous earth, should be entered as a function in the solution of the problem. The practice in Chicago does not seem to take this into consideration.

C. K. Mohler—Figuring the weight of earth at 100 lb. per cu.ft., gives a vertical load of 6000 per sq.ft. at a depth of 60 ft. Plastic clay should balance that amount of column load without any settlement whatever. If the foundation well is completely filled, there will be the friction of the sides of the pier against the earth to resist settlement. With the clay perfectly confined at a depth of 60 ft. there should be no settlement possible, aside from what the soil may be actually compressed by the added load. On the other hand, a compression test in an open

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pit on plastic clay may be no proof of what it will carry when perfectly confined.

WM. ARTINGSTALL—I do not think there is any question in the engineer's mind about the moving of the soil. On opening any large excavation, one will have a great deal of trouble about the bottom coming up. It is a notable fact that since 1856, dredging of virgin clay out of the Chicago River has been going on. About every five years one can take out 2 or 3 ft. and get down to the desired plane, but four or five years afterward you can again take out 2 or 3 ft. of solid clay which is above the former limit of dredging. In building the west approach of the Washington St. tunnel we encountered the foundation piers of the columns of the C. & N. W. Ry. terminal. These were on piles driven to 50 or 60 ft. below datum. The columns settled about 2½ in. and moved laterally about 2 in.

F. L. STONE—In the track-elevation work of the C., B. & Q. R.R. from Canal St. to the city limits, our greatest trouble was in connection with the lateral movement of the abutments. We were able to carry our loads vertically on piling, but we had to take considerable precaution as to the lateral movement.

T. L. CONDRON—One feature of the foundation problem in Chicago that will eventually require legislation, it seems to me, is the practice (in sinking big foundations) of pumping them out and removing an unlimited quantity of material. This must disturb the surrounding soil, and accounts in a large measure, in my opinion, for the settling and lateral movements of surrounding buildings. Where it is impossible to do dry excavation, the excavating should be either stopped or carried on under compressed air. A good many of our large buildings have hardpan foundations, and they will carry an indefinite amount of load until somebody pumps out the material (silt or quicksand) beneath the hardpan.

Proportioning of Foundations for Columns and Walls

BY ERNEST MCCULLOUGH*

The writer has been struck with surprise a number of times when checking designs for buildings, at the apparent lack of information respecting a proper method for distributing loads to column and wall footings. Inasmuch as exterior columns carry a larger per cent. of dead load than interior columns, many designers content themselves with giving a slightly higher soil pressure on the interior footings. For example, in one city where the soil is commonly loaded to 3500 lb. per sq.ft., it is customary to use this for wall, and exterior column, footings and use 4000 lb. per sq.ft. for footings under interior columns and piers where the per cent. of live load is larger. As a rule in architects' offices no difference is made, the footings being proportioned according to total load, with the result that many floors break because of a greater settlement under the walls.

Experience shows that it is as disagreeable to have interior footings too large as to have them too small. In case they are too large the floors "hump," while in the case of small footings they "sink," when the buildings are occupied for any length of time, it being customary to put the bulk of merchandise close to walls and columns with vacant spaces and alleyways between interior columns. There is this difference, however, that the period of subsidence is short in the case of floors permanently carrying a fairly steady load and when the interior footings are too large, the rise after awhile becoming a fixed amount. When on the other hand, the interior footings are too small, the sinking continues for a very long time and causes so much uneasiness that frequently heavy expenses are incurred to increase the bearing surface, the cost of strutting up the floors being considerable. Why any more anxiety should be caused by the sinking of the interior columns than by sinking of the walls, the writer cannot say, but it is possibly due to the large area visibly affected, the sinking not being uniform.

A careful search of textbooks fails to reveal an explanation of any method for adequately proportioning the loads according to the differing percentages of live load, yet that such rules do exist in the offices of experienced men is very probable.

The writer lately undertook to collect some data on this subject and is forced to believe that the majority of designers use their judgment mainly in determining the portion of load to go to each column, or else they prefer to keep their methods secret. This being the case it may be of interest to engineers to see published the method used for some years by the writer and also by several engineers of his acquaintance. He makes no claim of originating this method, but has not been able, so far, to find it anywhere in print. Briefly, it consists in proportioning the footing for the column carrying the largest per cent. of dead load, multiplying the soil load by the per cent. of dead load, and then dividing this "soil factor" by the per cent. of dead load for the other columns to determine a proper bearing value. The following examples from a building recently designed will serve to illustrate the method; Col. 44 carries 8% of live load and 92% of dead load, it being a corner column under a tower carrying a water tank. The total load on the footing was 473,000 lb., which gave a footing measuring 8 ft. 3 in. x 8 ft. 3 in. The footing rests on a thick bed of sand which was tested and a bearing value of 7000 lb. per sq.ft. selected as proper. $7000 \times 92 = 644{,}000$, soil factor. Columns 1, 2, 3, etc., carried 62% of live load, and $644{,}000 \div 62 = 10{,}400$ lb. soil load per sq.ft. under these columns. 605,000 (total load) $\div$ 10,400 = 58.1 sq.ft., requiring a 7-ft. 8-in. x 7-ft. 8-in. footing. Similarly, columns 29, 30, 31, etc., carried 73% of live load and $644{,}000 \div 73 = 8850$ soil load per sq.ft. under the footings. The total load, 588,000 $\div$ 8850 = 64.45 sq.ft., requiring an 8-ft. 2-in. x 8-ft. 2-in. footing.

By the foregoing method it may be seen that the footings most likely to carry the calculated load permanently are designed to use the full allowance of soil pressure and the other footings which will only occasionally be loaded to anything like the calculated amount, will at such times load the soil more heavily, the greater part of the time the load being very light.

Another method used occasionally is that mentioned by C. C. Schneider, M. Am. Soc. C. E., in his "General Specifications for Structural Work for Buildings." It reads as follows:

> The areas of the bases of the foundations shall be proportioned for the dead load only. That foundation which receives the largest ratio of live to dead load shall be selected and proportioned for the combined dead and live loads. The dead load on this foundation shall be divided by the area thus found, and this reduced pressure per square foot shall be the permissible working pressure to be used for the dead load of all foundations.

*Consulting Engineer, Monadnock Block, Chicago, Ill.

For this method of figuring we begin with Col. 24, on which the load is 60% dead, 40% live, the total load being 632,000 lb. The footing required is 632,000 ÷ 7000 = 90.29 sq.ft., or 9 ft. 6 in. x 9 ft. 6 in. A comparison with the other method gives, soil factor 644,000 ÷ 60 = 10,750 lb. per sq.ft., and 632,000 ÷ 10,750 = 58.8 sq.ft., requiring a footing of 7 ft. 8 in. x 7 ft. 8 in.

Proceeding by the Schneider method: The total load is 632,000 lb. and the dead load is 378,000 lb. The area of the footing, found by dividing the total load by the allowable soil pressure, equals 95 sq.ft. The reduced soil pressure equals 378,000 ÷ 95 = 3980 lb. per sq.ft..

This soil pressure is now used for dead load only in proportioning the rest of the footings. Taking the examples already given, Col. 44, total load 473,000 lb. has a dead load of 433,000 lb., and this divided by 3980 gives a footing 10 ft. 5 in. x 10 ft. 5 in. Cols. 1, 2, 3, etc., total load of 605,000 lb., have a dead load of 372,000 lb., which divided by 3980 gives a footing 9 ft. 8 in. x 9 ft. 8 in. Similarly, Cols. 29, 30, 31, etc., total load 588,000 lb., have a dead load of 433,000 lb., which divided by 3980 gives footings 10 ft. 5 in. x 10 ft. 5 in.

By the Schneider method, the footings which only occasionally carry the full calculated load are designed for the allowable soil pressure when fully loaded. Consequently the footings probably never are loaded to the bearing capacity of the soil, this bearing capacity usually being from one-third to one-half the load the soil can carry on 1 sq.ft. of surface without appreciable settlement in 24 hr. The soil is generally tested with a load on a post 12 in. square, which is far more severe than anything any future loading can bring upon it. Foundations cost money and a discussion of the comparative merits of these two systems for proportioning loads on footings should be of value to both engineers and architects.

In the case above figured, the footings being designed by both methods and the method giving the smallest footing adopted, the column loads were reduced by the common rule to be found in the greater number of American building laws. The full live and dead loads on the roof are carried to the supporting columns on the top floor. The live load on the top floor is reduced 15%, with a progressive reduction of 5% for each floor below until the total reduction amounts to 50% of the live load, from which point the live load on floors below is taken at 50%. For a building eight stories high this gives practically 70% of the total live load on the footings.

In some foreign countries, and in a number of buildings erected in America in places where no building laws protect the owner, a common practice is to take 100% of the live and dead loads on the roof and 10% progressive reduction on each floor below until this reduction reaches a floor where only 40% of the live load is used. On all floors below only 40% of the live load is used for each floor, but on the footings the amount of live load in the total load is taken at 40% of all the live load on all the floors. In some places where the first rule is used for reducing live loads to columns it is customary to use 50% of the total live load in designing footings.

Surely the art of building is old enough and there are enough competent engineers in the world to enable questions such as these to be definitely settled. The strangest part about the matter is the fact that all textbooks are so vague and perhaps this is for the reason that the writers of the textbooks believe these things are settled. There is no common practice at present and practical contractors are fond of telling about the different rules given by engineers and architects of standing, when asked how to reduce live loads to columns and how to proportion footings for live and dead loads.

A 500-ton Reinforced-concrete Scow

By C. E. Sudler*

A reinforced-concrete scow or lighter, designed to carry a load of 500 tons, was launched at the yard of the Furst Concrete Scow Construction Co., at Baltimore, Md., on Dec. 31, 1912. This scow is the first of a number which this company is intending to build and for the construction of which they have recently equipped a large shipyard. A view of the vessel on the building platform is shown in Fig. 1, and Fig. 2 gives the general details of its construction.

It has a total length over guards of 113 ft., a breadth over guards of 29 ft., and an outside depth of 10 ft. 6 in. The cross-section shows rounded bilges which are worked into sloping ends, showing on the deck plan as quarter ellipses, a form adopted to give an easy towing body and also as offering maximum strength for the quantity of

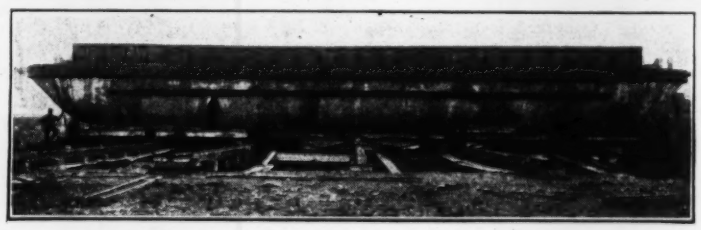

Fig. 1. Reinforced-concrete Scow on the Ways before Launching

material used. The lighter is strengthened and divided into 20 watertight compartments by two longitudinal bulkheads extending the full length of the hull, five athwartship bulkheads and two additional longitudinal bulkheads on the center line extending from each end to the first cross bulkhead. Provision is made to drain each compartment and to test it for leakage by a series of pipes and cocks leading to each end of the vessel. Access to each compartment can be had through manholes in the deck, which are closed and sealed tight by flush-plates, only to be opened in case repairs are needed.

The walls are divided into panels of suitable size by a series of beams both vertical and horizontal, the main slabs forming the walls being 3 to 5 in. thick and reinforced with plain bars running in both directions. Deformed bars are used for the reinforcement of the beams.

A heavy timber guard 24 in. in depth extends clear around the vessel at the deck and in addition a lower guard 6x10 in. in section is used to protect the hull when light. Above the deck proper there rises a timber siding, as shown in the views and in the cut.

The lighter was built entirely of concrete poured between inside and outside forms. This method of building was considered as being more reliable than the occasionally used method of building barges by plastering successive coats on wire mesh to form the walls. By this

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latter method any defective bond between coats would greatly weaken the walls. It is, of course, much cheaper on account of the saving in the form work and in placing the reinforcing steel, as in the method of pouring between forms, which was used on this lighter, it was necessary to assemble the steel as the forms were set up.

The outside forms were comparatively simple, being built of wood in sections that could be conveniently handled and removed without damage. The inner forms were far more troublesome. On account of the thin walls they had to be built very accurately to size and squared up perfectly true. Some trouble was had in making a type of form that could be removed readily after the concrete was in place. This was due to the fact that most of the inner walls were divided by beams into panels of approximately 7 ft. square, and the form making the slab was surrounded on four sides by the sides of the adjacent beams. The swelling of the wood of such a form would cause it to bind tight on the four sides so that it could not be removed without destroying its usefulness. The inner forms were separated from the outer by small cement blocks, cast with holes through which were placed the bolts to draw the forms together.

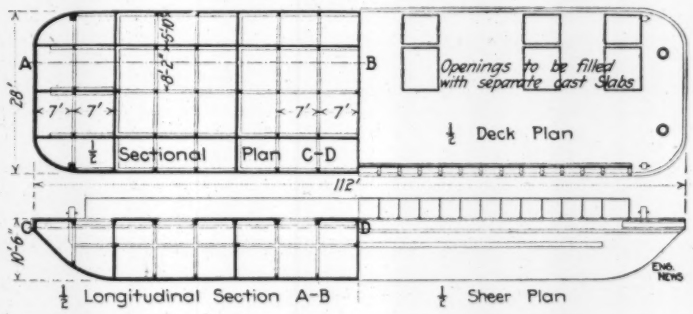

FIG. 2. DETAILS OF THE FURST CONCRETE SCOW

Concrete materials were measured and handled in small dump cars and emptied into a batch mixer located about 10 ft. higher than the deck of the scow. The mixed concrete was dumped into a storage hopper from which it was drawn into two-wheeled carts and pushed by men on a level runway to the place required. The concrete was not placed continuously, but at the outset the work was divided into sections which could be placed in one day, leaving joints in certain places where the concrete could be thoroughly cleaned, roughened and bonded with the next section. The walls were protected from the sun and kept wet for about 10 days after the concrete was placed.

A very rich concrete was used, mixed quite wet, but no other precaution in the way of waterproofing materials or paints, etc., were used to make the walls watertight. It is evident that the method of mixing and the materials used resulted in a very good concrete because no leakage has been noted in the six or eight weeks during which the scow has been in the water.

The company which has undertaken the manufacture of this scow has opened a six-acre plot of waterfront property in Baltimore for general marine repairs and construction, and particularly for the design and construction of reinforced-concrete lighters which might successfully compete with the older forms of construction. The plant as built consists of a machine shop, forge shop, compressed-air plant, wood-working shops, and a 1000-ton railway dry dock for the double purpose of docking vessels for repairs and launching the concrete scows. The scows are built on a platform supported on rollers alongside the railway so that both scow and platform may be moved bodily sidewise onto the cradle of the railway and then the whole lowered into the water. This permits launching a green or unseasoned concrete vessel without the least strain.

Actual construction of the vessel illustrated was started about July 10, 1912, and all concrete work was completed about Nov. 15. As stated above, it was launched on Dec. 31. Since it was launched it has been quite thoroughly tested in constant service in handling sand and gravel, which is loaded by a dredge and unloaded by grab buckets. It appears to be thoroughly practical and successful in every way. It has shown no sign of leakage and offers less resistance in towing than a wooden lighter of the same capacity. The tug-boat captains who have handled it state that it tows more easily than most wooden lighters.

The organization of the Furst Concrete Scow Construction Co. is primarily due to Oscar F. Lackey, Harbor Engineer of Baltimore, who holds a U. S. patent on the scow as shown in the design herewith. The president of the company is Frank A. Furst, and the writer is the designing and constructing engineer.

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Electric Traction is to replace steam on several important English suburban roads, according to recent announcements. The single-phase system of the London, Brighton & South Coast Ry. in England is to be extended, so as to include the suburban lines extending from London to Croydon, Purley and Coulsden, and to Cheam. As noted in "Engineering News" of June 8, 1911, service on parts of the Brighton road has been operated for over three years under this system. The first extension beyond the initial and experimental development was on the Victoria-Crystal Palace line, as noted in our former issue, and so far the equivalent of about 70 miles of single track is under single-phase traction. The proposed changes will bring this up to 220 miles. The present rolling stock consists of 50 motor coaches, and this will be increased to 200. Energy is bought from the London Electric Supply Corporation at present, and it is intended to purchase all current required for the enlarged system from this company. This will require the addition of something like 50,000 kw. in additional capacity, making the corporation's station at Deptford one of the largest in the country. There still will be a stretch, some 35 miles long, to Brighton to be electrified, and two similar lines which probably will not be converted under present conditions.

It is reported that the London & Southwestern Ry. Co. has definitely decided to begin the electrification of suburban lines by equipping the circular route from Waterloo to Wimbleton, Kingston, Twickenham, Richmond, and back to Waterloo again, and a connecting link with the existing line between East Putney and Wimbleton. The company has decided upon the direct-current third rail system at 600 volts, with return current in the running rails. This decision was effected largely by the fact that other London electric lines, including the Metropolitan District system, whose trains run through Richmond and Wimbleton over the Southwestern company's rails use direct current at this voltage. The company proposes to erect its own power house with a capacity of 25,000 kw. Three-phase energy will be transmitted and converted with rotating machinery at five substations. The trackage noted is equivalent to about 73 miles single track. The other portions of the system which it is proposed to convert present a further length of 173 miles, single track.

In "Engineering News," Apr. 11, 1912, the improvements inaugurated by the London & Northwestern Ry. were noted, including the construction of the new electric line from Euston to Watford, running alongside the main line and intended to relieve the latter of its suburban traffic, together with the electrification of the various lines to Camdentown, Willesden, Earlsport, etc. The system of electric traction adopted is the direct-current, 600-volt, using third and fourth rails in accordance with the system already adopted by the Metropolitan District Ry., which leaves the running rails free for the installation of track circuits and automatic signals. The company will have its own power station near Wembley station where a good supply of water is obtainable. The initial capacity will be 25,000 kw., in steam turbine generators; the station will work on a 11,000-volt, three-phase, 25-cycle system.

The Reclamation of Ancient Babylonia By Irrigation

By Edgar J. Banks*

"Egypt is the gift of the Nile," is a true saying and as old as the history of Herodotus; but the Nile is not the only river which has given a great and famous country to the world. The Tigris and the Euphrates, rising in the mountains of Armenia, have carried down and deposited much of the best of that country at their mouths. It was thus Babylonia came into existence.

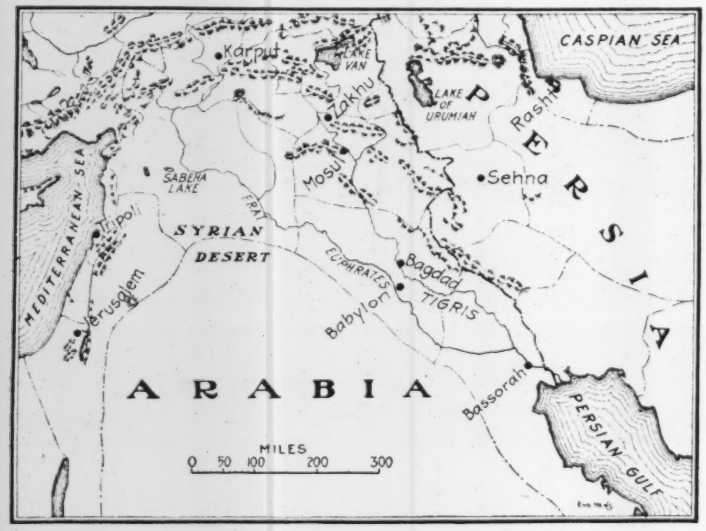

Fig. 1. Map of Babylonia; a Once Fertile Country about to be Reclaimed at a Cost of $60,000,000

It is estimated that the Persian Gulf is growing shorter, or that Babylonia is growing longer, at the rate of a mile every 30 years. There was a time when the Persian Gulf extended northward about 250 miles farther than it does now, or to Bagdad. There, at the city of the Caliphs, the alluvial plain of Babylonia begins, and the rolling, stony Assyria ends. The alluvial Babylonian plain is one of the most fertile lands of the world.

As far back as Babylonian history goes, and excavations in the ruins of the Mesopotamian cities have yielded a mass of records of some 6000 years ago, the fertility of Babylonia was maintained by means of an extensive and intricate system of irrigation canals. Great canals, as large as rivers, ran parallel with the Tigris and Euphrates, and scores of others intersected the valley, connecting the two streams. There was scarcely a corner of the entire country which was not well watered; and, more than that, the canals served as waterways for the transportation of the crops.

Some 2500 years ago the city of Babylon fell. Less civilized people overran and occupied the fertile valley. The old canals were allowed to become choked up with silt brought down by the rivers in the spring-flood seasons. The date palms died, and in time the country became as dry, and apparently as barren, as any part of the Arabian desert. For centuries the valley has been scarcely more than a grazing ground for great herds of camels belonging to desert tribes.

However, two of the old canals have remained open, and during the season of high water they are navigable for the native craft. Only here and there along their shores and along the shores of the rivers are small patches of cultivated land, as rich as in the days of old, when Herodotus refused to speak of the fertility of Babylonia; for he thought that none would believe him. Southern Babylonia, which is more or less a huge swamp, is still the date garden of the world; but as you wander north and south through the center of the country, crossing every few miles the bed of an ancient canal, it is evident that all Babylonia was once a garden spot.

A dozen years ago Sir William Willcocks, the constructor of the great Nile dam at Assuan, visited Babylonia to investigate the old system of canalization, with a view to reviving it and reclaiming the country. He became enthusiastic over its great possibilities, yet at the time, under the old régime in Turkey, nothing could be done.

The former attitude of the Turkish government may be illustrated by a story told of an Arab peasant who owned some land along the Tigris. One day the Arab came to Bagdad to obtain the governor's permission to dig a ditch from the river out to his land to water it. The governor listened to the petition, and then gravely remarked, "that when Allah created the world, he made the Tigris River to carry the water from the mountains of Armenia down to the Persian Gulf, and if Allah had wished for a ditch out to his land, he would have dug one when he created the world."

Under the new régime, the attitude of the Turks has changed. Again Sir William Willcocks went to Babylonia, this time at the invitation of the Turkish government, and every facility was given him to study the conditions. As a result, Babylonia is being reclaimed; already Sir William's great project is being carried into execution. A system of canals as extensive and as complicated, perhaps, as that of the ancient Babylonians, is

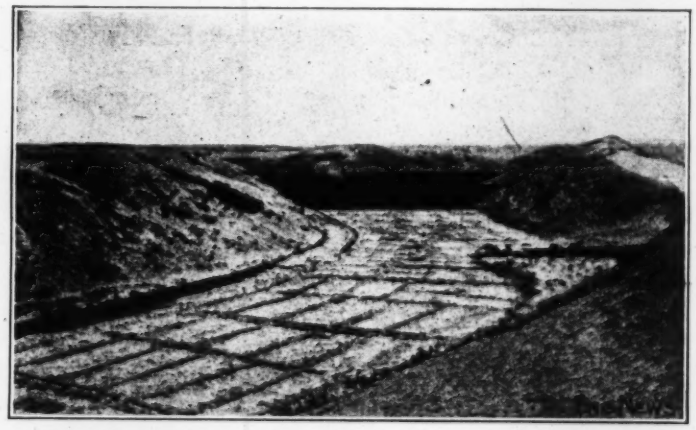

Fig. 2. Bed of an Ancient Irrigation Canal under Cultivation

under way, and again Babylonia promises to become as productive as in the days of Herodotus.

The irrigation project is so extensive that under the most favorable conditions more than half a century will be required for its completion. The estimated cost is in the vicinity of $60,000,000—a huge sum for a debt-ridden country like Turkey. The value the reclamation work will be to the country is, however, almost beyond computation.

The first step in the construction of the irrigation system is the building of a large dam across the Euphrates near Feluja, north of the ruins of the ancient city of

*Greenfield, Mass. (Mr. Banks recently returned from a trip through Babylonia.—Ed.)

Babylon. That dam, now nearing completion, will control the waters of the river, releasing them to flow down the Euphrates bed, or down the Hindieh, a parallel stream, as they are needed. Higher up the Euphrates, near Hit, another dam is being constructed in connection with a canal to reach across the valley to the Tigris, and to carry away the silt-laden floods of the springtime, thus preventing the choking up of the smaller irrigating canals below.

The Shatt en-Nil and the Shatt el-Hai, old Babylonian canals, still containing water during a part of the year, and others long filled up, are to be reopened. A score of streams connecting the Tigris and Euphrates,

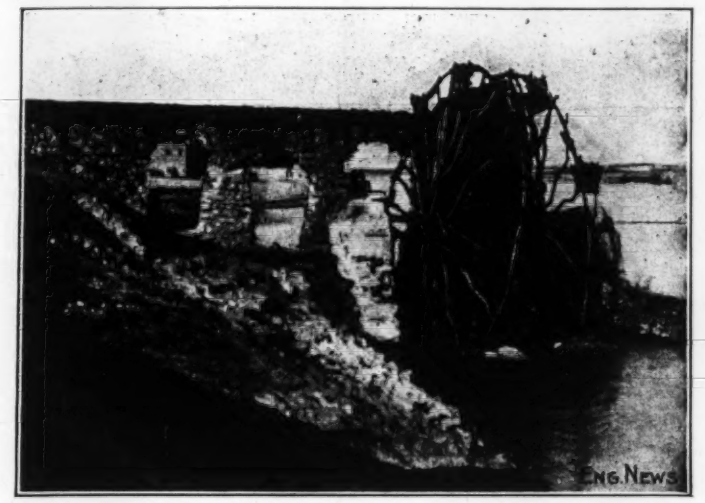

FIG. 3. WHEEL OPERATED BY CURRENT FOR RAISING WATER FOR IRRIGATION

will carry the water of the rivers to every part of the lower valley. The great malarial swamps of Southern Babylonia, parts of which are uninhabited and almost impenetrable, will no longer receive much of the water now flowing into them; then the remaining surplus water may be drained away, and the extent of the date-bearing region of Babylonia will be enormously increased.

Most of the soil of Babylonia, idle for two thousand years or more, is saturated with salt; in some places the surface is incrusted with it. The irrigation project provides for a secondary system of canals running throughout the valley, to cleanse the soil by washing the salt away, and carrying it down to the Persian Gulf.

The work of construction is in the hands of a British corporation, and is paid for by the Turkish government as sections of it are completed. Thirty British engineers and thousands of native workmen are employed. So great is the area of the country which will be reclaimed that the engineers fear that people enough to take up the land cannot be found as they are needed. Already the Arabs are pouring in from the north, yet the Arabs of all the tribes might settle in Babylonia, and then there would be land to spare.

At the present time there are two lines of steamboats on the Tigris River, running between Bagdad and Busreh, one British and one Turkish. Half a dozen boats carry practically all the freight to and from Bagdad; caravans of camels, laden with heavy merchandise, now seldom cross the desert. The boats, drawing only about 3 ft. of water, find difficulty during the dry season in navigating the shallow river; and when the greater part of the water shall be used for irrigating purposes, river navigation must cease. However, probably long before then, a railroad will be constructed along the Tigris shore, and the journey between Bagdad and Busreh, which now sometimes requires a week, may be made in a single day.

Along with the government irrigation scheme, the Bagdad railroad is assisting in reclaiming Babylonia. On the western side of the desert, the road, which has been under construction for several years, has reached the Euphrates. In the autumn of 1912, work was begun at the Bagdad end. Two locomotives, the first ever seen in Bagdad, were brought by boat up the river; storehouses, hospitals and homes for the officials have been constructed, and the work of laying the tracks has begun. The Germans, who are building the railroad, estimate that in three years the two ends will meet somewhere in the desert to the west of Mosul or the ruins of Ninevah. The entire track from Constantinople to Bagdad, including the Anatolian railroad through Asia Minor, will be 2600 km. in length, and then the journey, now exceedingly difficult and requiring a month or more, may be made in three days. Bagdad, so long shut off from the civilized world, will then be on the track of the tourist, and there will be an easy outlet for all the crops that Babylonia can produce.

It is still to be seen what effect the war in Turkey will have on these two projects. The Germans openly acknowledge that they expect complications to arise which will compel them to stop their work, and in the meantime they are pushing it with all possible speed. Money in Turkey is scarce; the war has impoverished the country and is disheartening the Turks, and strange would it be if work on the irrigating project is not hampered or temporarily suspended.

In the meantime the flat-bottomed boats will continue to ply the Tigris, and the great irrigating wheels on the Euphrates, turned by the current, just as they have been for the past two thousand years, will continue to water the little gardens along the shores. But ultimately, the Babylonian desert, now brown and barren from drought, will be brown from the ripening grain, and the "iron horse," more wonderful to the Arabs than Solomon's magic carpet, will bear the grain to the markets beyond the desert, and bring back gold.

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Street Paving in Walla Walla, Wash., is reviewed in the 1912 annual report of W. R. Rehorn, city engineer—the first city engineer's report for Walla Walla ever made, Mr. Rehorn states. Walla Walla has a total area of 3.9 sq.mi. Of its 66.6 miles of 40- to 100-ft. streets 40.3 miles are "improved" (graded) and 13 miles have been paved, including nearly three miles of macadam. About half of the street mileage is composed of strets 70, 80 (26.87) and 100 ft. in width.

Asphalt pavements totaling 148,900 sq.yd. in area and 5.65 miles in length have been laid from 1904 to date at an average cost of $2.15 per sq.yd. Some of the 1904 asphalt "is now in poor condition and is in need of repairs."

Bitulithic was laid in 1905-6 to the extent of 64,820 sq.yd., on 2.24 miles of streets, at an average cost of $2.17 per sq.yd. The report states that the bitulithic "has given satisfaction, but a portion of it is showing the need of a top coat, or what is known as a squeegee coat."

Concrete pavement has been laid in alleys, beginning with 1911, to a total of 8155 sq.yd. or 0.80 miles; at an average cost of $1.25 per sq.yd. So far it has been satisfactory.

Dolarway totaling 13,000 sq.yd. or a length of 0.73 miles was laid in the fall of 1912, under a five-year guarantee bond, at an average cost of $1.30 per sq.yd.

The total cost of 9.42 miles of street improvements (asphalt, bitulithic, concrete and dolarway), including grading, draining, paving and curbing, was $637,857 or nearly $6700 a mile. A small yardage of brick gutter paving, in the streets first paved with asphalt, cost $3.50 per sq.yd.

The Karns Tunneling Machine

By O. J. Grimes*

The latest idea in tunnel boring, the Karns tunneling machine, is operated similarly to the small air drill now used in drilling and blasting. It simply takes the place of the drill steel that goes into the chuck of the air drill except that it is heavier and must have a supporting carriage. The motion of the machine in operation is exactly the same as that of the small drill, the blows being delivered against the obstruction by direct forward motion. On the back stroke, the reciprocating parts turn slightly by means of a rotating device, similar to the rifle nut in the small drill, so that with each succeeding blow the cutting points strike the rock at a different place. The rock, instead of being ground into dust, falls down in small chips, resulting in more rapid progress.

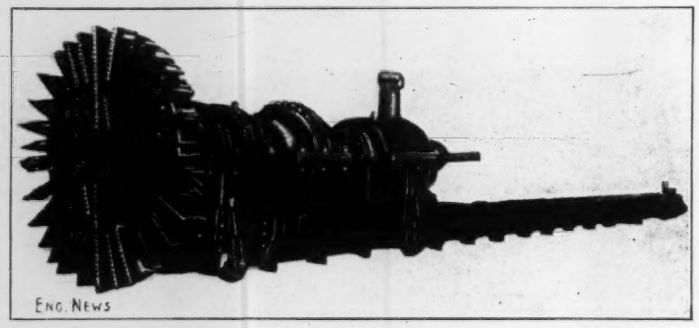

Fig. 1. Karns Tunneling Machine with Drill Head 6 Ft. in Diameter

The latest and largest machine constructed has a cutting head 6 ft. in diameter. It is not a combination of individual drills, but is a single drill with innumerable points, striking simultaneously and rapidly.

There are 41 cutter blades made of tool steel, each 1 in. thick, 5 in. wide and of various lengths. Points like saw teeth are machined on one edge and the other edge is fastened in the face of the head. These cutter blades are set in grooves 1 in. deep and backed on one side by an extra inch, to resist the pressure of the cut rock at the bottom when the head is turning. They are held in these grooves by two hook bolts to each cutter, which pass through the head and hold them firmly in place.

To remove the cutters, the nuts on the hook bolts are unscrewed about 1 in., permitting the cutters to be pulled forward and slipped off the ends of the bolts. The entire set of cutters may be removed and replaced in about 2 hr. One set will drive from 25 to 75 ft. of tunnel, depending on the hardness of the rock, although 97 ft. have been driven without a change.

The reciprocating parts of this machine weigh 7¼ tons. This weight is thrown against the rock about 140 times a minute, each blow making a working stroke of 7 in., cutting from 2 to 4 ft. of tunnel per hour.

The cylinders are inclosed in a shell and connected to the supporting parts of the operating machine by heavy rods. The shell supporting the cylinders is held firmly in place by four columns, two in front and two in the rear, jacked to the top and bottom of the tunnel. The columns, shell and machine are advanced simultaneously with each 6 ft. of tunnel driven. The weight of the machine rests on four wheels under the supporting carriage which run on heavy steel tracks on each side. These tracks are fastened to and move along with the carriage, eliminating the setting of tracks a second time.

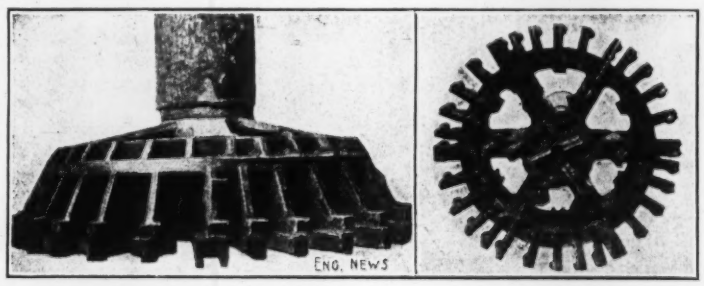

Fig. 2. Views of Rough Casting for Head of Karns Tunneling Machine

In the front cap of the machine are the front bearings, consisting of 48 steel balls, 3 in. in diameter, resting in 12 straight grooves, planed on the outside of the hub of the head casting. The other half of the grooves or bearings are on the inside of the heavy steel nut encircling the hub. The back bearings are under the rear cap and are similar to the front, except there are but 8 races of 3-in. balls, three in each row.

The middle cap covers the rotating device. It is the same as the front and back bearing except that the races

*Snow Apartments, Salt Lake City, Utah.

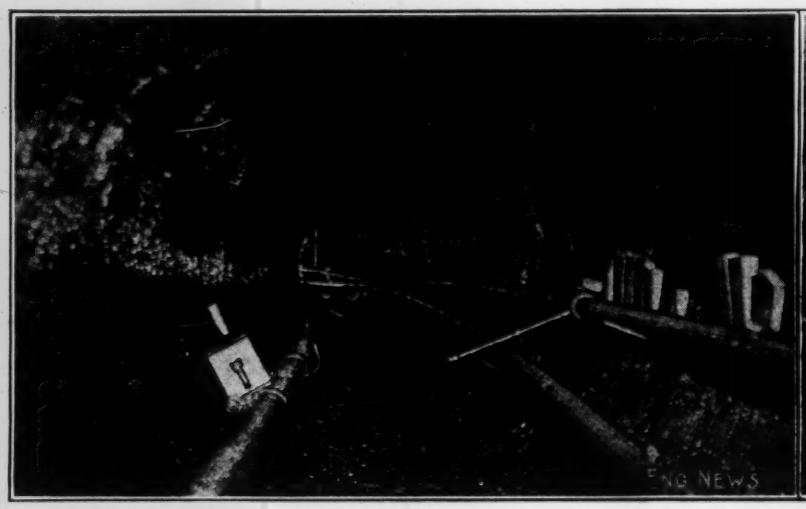

Fig. 3. A 6-ft. Diameter Tunnel Driven with the Karns Machine

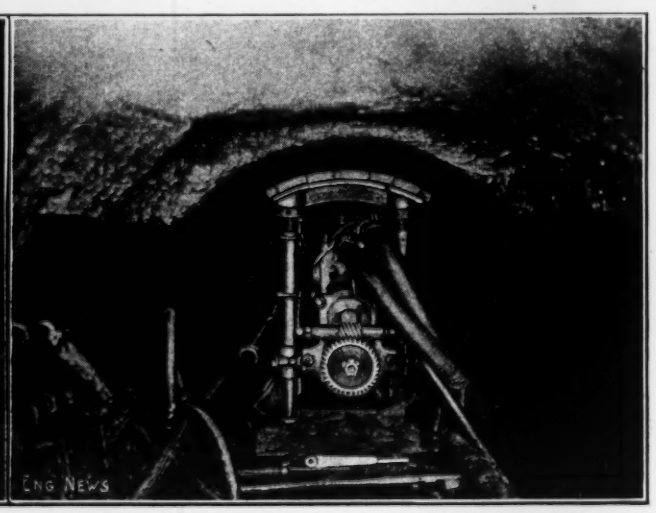

Fig. 4. Rear View of Karns Machine in Johnstown, Penn., Tunnel

for the 3-in. balls are spiral. There are four races with three balls in each race. On the outside of the steel nut there are ratchet teeth with dogs to drop into them on the back stroke and hold the nut from turning. This compels the shaft within to turn, as the ball races are spiral. On the forward stroke the motion is reversed and the nut turns, the dogs simply sliding over the ratchet teeth on the nut.

Having been fed ahead 6 ft., the moving up of the shell and holding columns under the cylinders on the feed screw is a very simple matter and requires but a few minutes. There is a truck under the shell supported by four wide-tired wheels on the rock. To move up, the columns are unjacked and made free. Then by a worm gear the surface of the supporting truck is raised so that the entire weight of the shell and columns rests on the truck. This done it is simply a matter of turning the feed screw which pulls all under the cylinders again. The surface of the truck is then lowered and the columns rest on the rock, the jacks at the top are tightened and all is ready for driving another 6 ft. of tunnel.

The engine driving this machine is a double, 9½-in., tandem cylinder, with an extreme stroke of 8¼ in.

To operate a machine of this size, 2000 cu.ft. of air per minute are required, but a plant capable of furnishing 3000 cu.ft. per minute is always installed. The purpose of the excess air is to make it easier on the compressor and boilers, thereby lengthening their lives, and to always have extra power available if a long stretch of very hard rock should be encountered. In such cases the additional air is used and the machine operated more rapidly, delivering much harder blows, with the result that the average speed is maintained throughout the work. A boiler of about 400 hp. is necessary to operate an air compressor of the required capacity.

To operate the machine on each shift, one runner and helper, two muckers, one engineer and a fireman are necessary. A blacksmith and helper are required one shift in three. The cost per foot to drive a tunnel with this machine ranges from $1 to $5, according to the rock and cost of fuel and labor at the place of installation.

Tunnels of large size can be driven quickly, safely and cheaply. If a round tunnel 18 ft. in diameter is desired, a tunnel 6 ft. in diameter may be driven through the center, and from it holes drilled 6 ft. deep in a circle with a small air drill. When blasted, the tunnel will be broken the full 18 ft. In enlarging, the rock will be shot into the tunnel, where there is sufficient room for handling the débris. The small tunnel acts as an air course through which the powder smoke passes, eliminating delays and expense now experienced in getting rid of it.

It was the idea of the late David H. Moffat to use a Karns machine to drive the gigantic tunnel through the divide on the line of his railroad, the Denver, Northwestern & Pacific. He went so far as to have a model 18 ft. in diameter constructed, but his untimely death halted all preparations.

The tests to which the Karns machines have been subjected were severe and practical. The first was made with a machine 52 in. in diameter through more than 100 ft. of solid granite near Boulder, Colo. The most recent demonstration was a tunnel 6 ft. in diameter and 200 ft. long, driven for the Valley Coal & Stone Co., near Johnstown, Penn. To show the adaptability of the machine to requirements, a 10° curve was driven as shown in the photograph.

The machine is controlled by the J. P. Karns Tunneling Machine Co., Mercantile Bank Building, Boulder, Colo. The inventor, J. P. Karns, President of the company, has offices at 518 Citizens Building, Cleveland, Ohio.

The Committee on Science and the Arts of the Franklin Institute, Philadelphia, last year awarded the Edward Longstreth medal to Mr. Karns for his invention of the tunneling machine.

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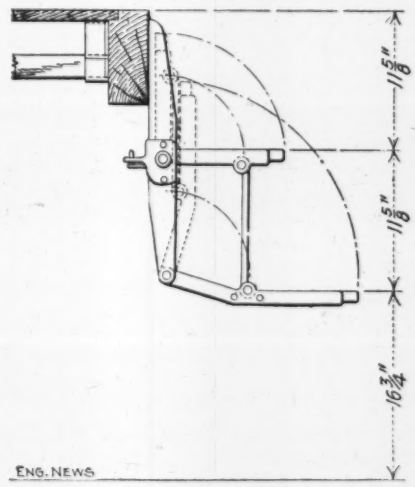
High Street-car Platforms with a Double Folding Step

The cars recently built for the Muskogee Electric Traction Co., in Oklahoma, show many features of novelty and interest; for instance, extremely light weight for a double-track 45-ft. car. This weight has been secured partially with the use of platforms level with the car floor, instead of the drop type, and very light side and corner posts. The omission of bulkheads and the use of level platforms, which are but 5 ft. long, has made possible a large body with a seating capacity of 52 persons, 44 occupying flat-back cross seats and eight on longitudinal seats near each corner post.



Double Folding Steps for Street Cars of Muskogee Electric Traction Co.

The cars are arranged for prepayment operation, except that some of the usual railings are omitted. The platforms are fitted with doors on both sides—on one side of each platform there being a single door at the motorman's right for exit only, with two on the other side for both exit and entrance when the car is running in the opposite direction. The entrance and exit doors are pivoted and work in unison with double folding steps. These were required in order to get a sufficiently low step with the very high platforms which were necessary in this construction. The arrangement of the step is shown in the accompanying diagram. The cars were built by the J. G. Brill Co., of Philadelphia.

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Depth of New Welland Canal—The Canadian Minister of Railways and Canals announced at the recent meeting of the Dominion Marine Association held at Toronto, that it had been definitely decided to make the locks of the new Welland Canal 30 ft. deep, although the canal itself will be but 24½ ft. deep for the present. The locks are to be built large enough to accommodate vessels 600 ft. long.

Large Fish Hatchery for the State of Kansas

By L. M. Bush*

The new Kansas State Fish Hatchery, located at Pratt, Kan., was put into operation on Nov. 1 and is the largest plant of its kind in the world. The hatchery is intended to furnish enough small fish to stock all the streams of the state, and all private ponds whose owners request fish.

Fig. 1. Intake Chamber and Section of Completed Concrete Dam

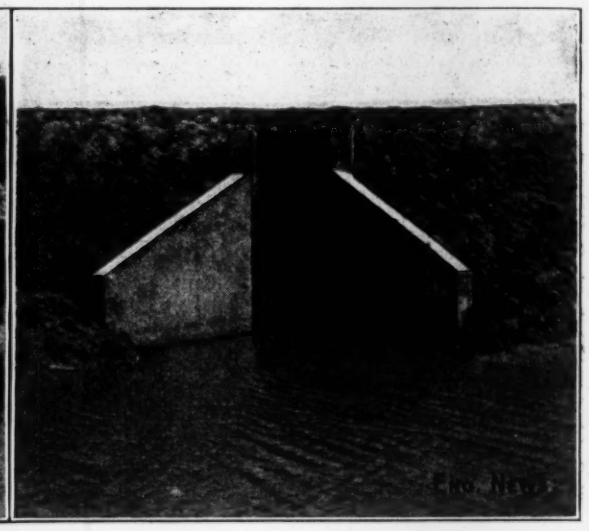

Fig. 2. Concrete Culvert Regulating Flow to Individual Ponds

The water supply for the hatchery is obtained by diverting the flow of the Ninnescah River by means of a low concrete dam, 500 ft. in length. This dam was constructed on a foundation protected by wooden sheet-piling, the piling penetrating into the clay subsoil. A concrete intake chamber (shown in Fig. 1), built at the east end of the dam, contains the central gates by which the water may be admitted into the conduit, or turned through a blow-off pipe into the river below the dam.

The water-supply conduit is a 21-in. vitrified clay pipe laid on a 0.113% grade from the intake portal to the hatchery grounds, 6875 ft. distant.

The pond system at the hatchery grounds (shown in Fig. 3) consists of 83 ponds of various sizes, having a total water surface of 65 acres. The water-surface area of each pond in acres is shown on the plan, Fig. 3. Seventy-one of the ponds have a maximum depth of water of 6.5 ft., and the other twelve have a 3.5-ft. depth. In all the ponds, the depth of water decreases near the shore to about 1 ft. The shallow ponds are each connected to a deep pond immediately adjoining it by a concrete culvert or distributor having no sluice gates. Slots in the walls of these distributors will permit screens to be inserted and the small bass, with which such ponds are stocked, may pass through the screens into the shallow water of the upper pond and be protected from the larger fish in the deep-water pond.

The pond embankments vary in width of crown from 6 ft. to 12 ft., with 2 on 1 side slopes, the crown being 1.5 ft. above the water surface. All banks between ponds of different depths are of 6-ft. crown, and all roadways are of 12-ft. crown. All other banks are built with an 8-ft. crown. The flow of water among the ponds is by gravity, the water surface of each pond being at least 6 in. lower than that of the pond immediately above it. The elevations of the water surfaces are shown on the plan, Fig. 3.

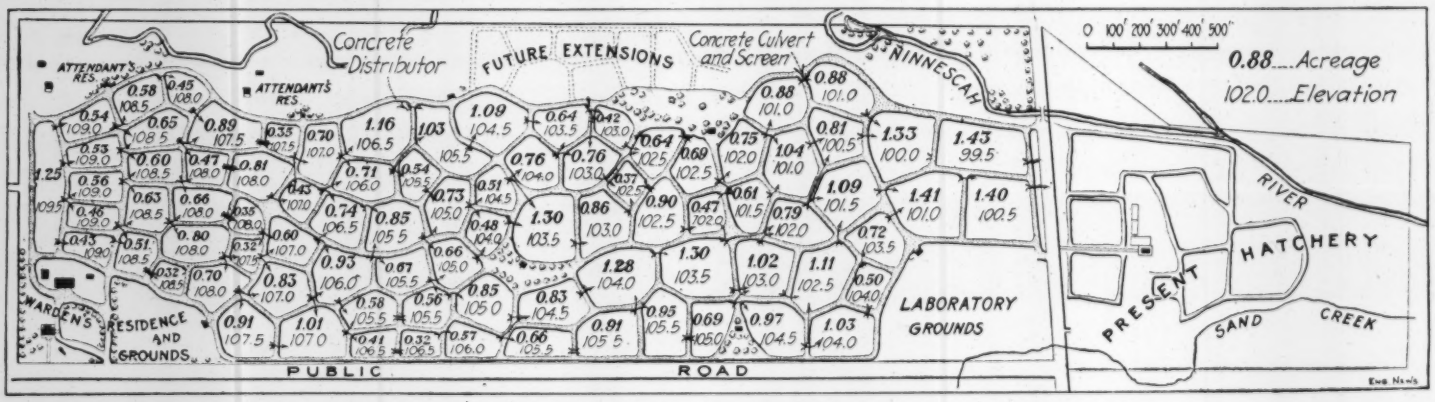

Fig. 3. Plan of the Kansas State Fish Hatchery, at Pratt, Kan.

Concrete distributors (shown in Fig. 2), equipped with sluice gates, are built in the bank of each deep pond and have service pipes leading to the ponds below. Some of the distributors have two service pipes leading to different ponds, and others only one, depending on their locality in the system. Ordinarily only one service pipe from each distributor will be in use, but in case one of the ponds is drained the flow of water can be diverted into some other pond. Each distributor is equipped with

*Assistant Resident Engineer, Pratt, Kan.

splash planks, fitting in slots in the walls, to maintain the head in the pond and with two sets of screens for keeping the fish in the ponds.

The drain-pipe lines for the pond system are laid beneath the embankments and connect each distributor with the main drain, which has an outlet to the river. Each distributor has an 8-in. sluice gate controlling the opening to the drain line and, by means of this, any pond may be drained without disturbing the other ponds. The exception to this is the case of a deep and shallow pond connected by a culvert, both of which are drained at the same time.

The most important items entering into the construction of the hatchery were 6915 ft. of 21-in. vitrified clay pipe, 880 ft. of 12-in., 3875 ft. of 10-in., 16,250 ft. of 8-in. vitrified clay pipe, and 140 galvanized-iron screens. Ninety-four small concrete structures were built, to which 193 bronze fitted sluice gates were attached. The total earthwork for the pond embankments amounted to 126,000 cu.yd. The cost of the entire plant was $60,000.

The hatchery plant was designed by Prof. W. C. Hoad, formerly of the University of Kansas, but now of the University of Michigan, and was built under the direction of Prof. L. L. Dyche, State Fish and Game Warden. The contract work was done by James A. Greene & Co., of Chicago, Ill.

Embedded Radiation for Heating Buildings

A low-temperature-radiation heating system, devised by A. H. Barker, has been applied recently to a group of buildings in Liverpool, England, the Royal Liver Buildings. This particular installation uses hot water and has about 120,000 sq.ft. of radiating surface. The system is applicable to steam heating also. It is described by the term "hot panel and hot floor border system," and consists in heating pipes embedded in the floor and the walls near the surface, the pipes being arranged in vertical panels in the walls and in strips around the floor of the room. The embedding material is a semi-conducting composition whose nature is not stated.

The installation in question was described recently by Capt. H. R. Sankey, R. E., in a lecture before the Junior Institution of Engineers (London, England). He stated that experience in the Royal Liver Buildings indicates that the "hot panel and hot floor border system" requires about the same amount of radiating surface as when ordinary hot-water radiators are used, but that the heating apparatus and the distribution system can be about 20% smaller on account of the greater efficiency of heating.

In the Royal Liver Buildings the installation of wall panels consists of iron-frame units containing ½-in. drawn lap-welded pipe bent backward and forward, and embedded in the semi-conducting composition already mentioned. The hot floor border consists of similar ½-in. drawn-steel pipe (not bent backward and forward, however), embedded about an inch below the floor in a strip running around the room near the wall, 6 to 18 in. wide.

The wall panels are vertical, and are set about 1½ in. away from the wall; the space behind is connected with the outside by a fresh-air grating and with the room by way of a register. The main wall behind each heating panel is coated with non-conducting plaster; the radiation by which the room is chiefly warmed is given out from the front of the panel and the side facing the wall serves to heat the incoming air. Floor borders are formed on two or more sides of each room according to the requirements. The corridors have borders 6 in. wide formed along each side for the full length of the corridor. The material in which the floor pipes are embedded is also used as a floor covering on the remainder of the floor and thus joints are avoided.

The floor borders and wall panels are controlled by separate valves and in the corridors the floor borders are divided up into sections separately controlled for adjusting the heat to the requirements. Generally a surface temperature of 100 to 110° F. is maintained.

All joints in the ½-in. heating pipes were welded by oxyacetylene flame. The installation (which, as already noted, contains about 120,000 sq.ft. of radiating surface) has 30,000 oxyacetylene welds; none of these has leaked since the installation was completed in 1911. Barry electrically-indicating thermometers are provided at different points in the building and they can be read from the heater room, thus giving the necessary indications for controlling the amount of heat supplied.

The same system has been applied in a new building of the Amalgamated Press in Farringdon St., Liverpool, and in the Midland Adelphi Hotel. In the former case the main staircase, which has its wall faced with marble, is fitted with heating panels in the frieze between the top of the marble casing and the ceiling. These panels are about 12 in. wide. In another place in the building the heating panels were placed in the ceiling. In both instances it is claimed the heating appears to be just as effective as that at the floor level.

A Large Masonry Arch Bridge has recently been completed across the River Thur in Switzerland on the new railway, between Ebnat and Neslau. The main arch of this bridge has a clear span of 207.6 ft. (63.26 m.), and a span from center to center of the rib at the skewback of 214.3 ft. The rise of the arch is 45.4 ft., and the ribs vary in thickness from 8.9 ft. at the skewback to 5.9 ft. at the crown. The roadway is 14.0 ft. wide between railways and carries a single-track railway line. It is carried on spandrel arches resting on spandrel columns, which in turn rest on the single-barrel arch. The rib is built alternating three and four rows of cut stone voussoirs.

Excavating Machinery for Land Drainage is being introduced in the Southeastern Drainage District of the State of South Australia. This district comprises an area of nearly 2,000,000 acres, which requires an elaborate system of drainage for proper utilization of the land. At present the system is complete for a small area only, around the township of Millicent. The drainage works have been in progress for several years, but until last year the process of excavation had been very primitive, and it is only during the last twelve months that machinery has been employed on the works. Previously, the method was not only primitive, but the progress was slow. The varied nature of the materials to be removed, however, has always made the work interesting, and it is this varied nature of the ground which has been unsuitable for many of the machines of recent invention and design. During the latter part of 1912 the District erected two Ruston & Proctor 17-ton steam shovels (with a bucket capacity of 2½ cu.yd.), one Bucyrus drag-line scraper of 1½ cu.yd. capacity, and one Priestman grab bucket excavator. In January, 1913, it was erecting one centrifugal pump dredge, and an Austin excavating machine. The district has constructed 1000 miles of drains varying in size up to 50 ft. bottom width, at a total expenditure of $2,000,000. F. N. Burchell, who is located at Beachport, is Superintending Officer of the Southeastern Drainage District, under the Engineer-in-Chief's Department of the state government, and has been connected with the works for about 30 years.

Sewage Pollution of Lake Michigan from the Calumet District

The problem of checking the present and increasing sewage pollution of the Grand Calumet and Little Calumet rivers and the south end of Lake Michigan is complicated by the fact that the district from which this pollution comes is divided by the Illinois-Indiana state line, which thus arbitrarily limits the jurisdiction of authorities having regulating power. On the Illinois side, the district is within the boundaries of the Sanitary District of Chicago, but there is no corresponding authority on the Indiana side. The serious conditions of pollution at this part of the lake, and its relation to the public health of several towns and cities have been reviewed in our columns,* and the Sanitary District of Chicago has recently called the attention of Governor Marshall of Indiana to the necessity of taking some steps for the control of the situation by some public authority. It is pointed out that the Indiana State Board of Health has called attention to the existing nuisance in the Calumet River at Hammond and the adjoining towns, and has emphasized the prevalence of extremely high typhoid rates, which indicate polluted water wherever taken from the southern end of the lake.

The Sanitary District of Chicago is now constructing a canal from the Calumet River to communicate with the main drainage channel at the "Sag," in order to divert the sewage of the southern part of Chicago from Lake Michigan, and it is believed that when this is completed the Indiana cities should be prepared to keep their end of Lake Michigan reasonably free from pollution. If they wish to divert the sewage from the lake and to turn it into the Calumet River, the Sanitary District will require that the effluent be in such shape as to require no additional oxygen for its purification. The opinion of the engineers of the Sanitary District is that the most good can be accomplished by the organization of a sanitary district in northern Indiana, which will include all towns draining into the Grand Calumet and Little Calumet rivers and Lake Michigan. The population is growing fast and spreading, so that conditions are rapidly becoming worse and affecting a greater territory. A nonputrescible effluent from Indiana will, therefore, be a necessity if it is taken into the Calumet-Sag Canal. The engineers have made a preliminary study of a system for the sewage of the Calumet district in Indiana, including not only intercepting sewers and sewage-pumping stations, but also complete treatment works, including grit chambers, Imhoff tanks, sprinkling filters and secondary settling basins. By this combination a very stable effluent will be secured, which will require no additional oxygen from diluting water, and will prevent a nuisance in the Calumet River as well as prevent the formation of sludge deposits. The total estimated cost of the works, including allowance for engineering and contingencies, is $1,258,238, with an annual cost of $214,570, including interest and depreciation as well as operating charges. This, however, does not cover the cost of the treatment required at Gary, Ind. Excessive storm water flows are to be diverted to the river without treatment, but should it be decided to disinfect the portion of the storm water discharged in Illinois, the Indiana portion of such water should be disinfected also.

*"Engineering News," June 16, 1910, and Nov. 18, 1909.

Some Curious Exhibits at the 1913 Motor Boat Show in New York City

A considerable part of the space at the annual Motor Boat Show, held at Madison Square Garden during the week of Feb. 15-22, was devoted to the exhibition of various styles of hydroplane boats. Single and multiple stepped, V-shaped, and center-slotted bottoms were shown and the bow shapes ranged from the vertical to the modified scow type. There seemed to be no standard type or design of motor, and the number of cylinders appeared to bear not the slightest relation to the size or power requirements of the engines. Some small six-cylinder motors were shown, also some large two- and four-cylinder engines.

A model of the "Baby Reliance II," and the original "Peter Pan V" were among the features exhibited which attracted most attention. Each of these boats has made a speed above 40 m.p.h. Another boat shown was a 40-ft. hydroplane designed for 65 m.p.h. and "guaranteed" for 60 m.p.h. This boat has not yet had an opportunity to prove its ability to achieve such a speed.

The Curtiss Flying Boat is a hybrid craft which can either roll, float or fly, so that it is at home on the earth, in the water or in the air. The boat hull is of wood, 26 ft. long, with a beam of about 4 ft. Small wheels, which can be raised and lowered at will, enable the boat to travel on fairly level ground, such as a smooth road or beach. A superstructure carrying biplane wings is attached to the boat near the center and carries the driving motor and single large propeller. The boat is driven by this air propeller whether traveling on land, water or air, and with it speeds of 50 m.p.h. on the water and over 60 m.p.h. in the air are claimed. The weight of the Flying Boat completely equipped is about 1300 lb.

The engine used in this craft is an 8-cylinder, 4-cycle machine, with two sets of cylinders set 90° apart. The engine weighs about 290 lb. and is rated at 75 hp.

Notable engineering skill has been displayed in working out the problem of controlling the operation of this craft in the air. The designer has contrived to produce stability automatically by the natural motions of the driver in maintaining his own equilibrium. The steering wheel is double, so that either of the two occupants can guide the machine without moving from his seat. The turning of this wheel controls the lateral turning of the machine. The raising and lowering operations are controlled by the relative positions of the steering wheel shaft, which is pivoted at its lower end so that it swings freely in a fore and aft direction. In case the craft should show a sudden tendency to rise, the operator would naturally lean forward to maintain his own equilibrium, and this movement communicated to the steering-wheel shaft, acts to force the craft back to a stable position. A similar righting action is exerted in case the plane tends to dip downward. To help in maintaining a stable condition while making turns, the boat is equipped with two small auxiliary planes between and at the extremities of the main planes. These smaller planes are actuated by a system of levers so connected that, when on turning the machine tends to dip too much to one side or the other, the natural tendency of the occupant to lean toward the high side will operate to restore equilibrium.

EDITORIALS

Closely following the death of the great American engineer, John Fritz, comes the news of the death of one of the most eminent engineers of Great Britain, Sir William White. As many of our readers will recall, Sir William was the recipient of the John Fritz medal from the Board of Award representing the engineering societies of America at a notable gathering in New York City in the fall of 1911.

Few English engineers of the present day were as widely known in the United States as Sir William White, and none has won a wider circle of friends. Readers of the biography of John Fritz, which we printed a fortnight ago, will be interested to compare his career with that of the famous English engineer. Each of these men achieved the highest pinnacle of professional honor and success, and were loved by fellow members of their profession throughout a wide circle as few men have been. Each of these men won his notable success solely by his own industry and ability and fine personal qualities.

It has been well said that to achieve great success constitutes one of the severest tests to which any man can be subjected. Different as these two great engineers were in many personal qualities, they were alike in this, that success left them absolutely unspoiled. Modesty, simplicity and genuineness were essential notes in the character of each. The many American engineers who knew Sir William White will unite with their British brethren in deep regret that he was not spared to enjoy for many more years the honors he had so well earned.

More Information Concerning Tunneling Machines

Four or five years ago, as many of our readers will recall, there was considerable agitation concerning the development of machines for driving tunnels by chopping the rock into chips by mechanical power. A number of such machines were invented and a few were actually built and tried. On page 572 of our issue of May 27, 1909, a brief review and description was given of a number of these machines.

It is scarcely strange that the years which have elapsed since that time have not been sufficient to bring any of these machines to commercial success, for the mechanical difficulties involved in the design of such a machine are extremely great. Many engineers indeed think they are so great as to be insurmountable. The problem is one, moreover, where experimenting must be done on a large scale and involves heavy expense; and the usual difficulties of inventors in securing capital for revolutionary new devices are quite sufficient to account for the slow progress of the tunneling machine.

The inventors, however, have not given up the fight. A few months ago we inspected a new tunneling machine built by Dr. Olin F. Proctor in a machine shop in New York City, which has since that time, we understand, been subjected to actual trial. Elsewhere in this issue a contributor in Salt Lake City gives an account of the Karns machine, considerably fuller than any which has been heretofore published. We have information from other sources that the late David H. Moffatt and his associates gave serious consideration to the Karns tunneling machine for driving their projected great tunnel through the Continental divide.

It is noteworthy that the proposal of those backing the Karns machine is not to drive full-sized railway tunnels, but only an advance heading 6 ft. or so in diameter. Ordinary drilling and blasting methods would then be used to enlarge the heading to the final cross-section desired.

A difficulty which would be met in this method of operation, however, would be the trouble in keeping intact the large compressed-air mains which are required to supply the air to the tunneling machine. These mains would be liable to frequent breakage if drilling and blasting were going on at the bench behind the machine. Of course, where time was not important, the tunneling machine could be driven clear through the heading first and the bench could be taken out afterward.

Without being too sanguine as to the ultimate success of tunneling machines, it may at least be said that their inventors deserve some credit for their courage and persistency in endeavoring to perfect their devices considering the very great difficulties which they have in face.

The Financial Aspect of Railway Terminal Electrification

Eight or ten years ago numerous projects were in the air for the operation of railway terminal and suburban lines by electricity. Elaborate investigations were carried out for a number of important railways looking to the electrification of terminal and suburban lines in the vicinity of New York, Boston, Chicago, and, we believe, one or two other cities.

One hears not infrequently the inquiry from laymen as to why nothing further is being done toward carrying these various projects into effect. An excellent answer to such inquiries is furnished in the recent testimony given by James J. Hustis, Vice-President of the New York Central R.R. and in charge of the Boston & Albany R.R., which is leased by the Central, before the railroad committee of the Massachusetts Legislature.

That body has now before it a bill which comes up every year compelling the various railways around Boston to adopt electricity for the propulsion of all trains within the city limits. It may be remarked in the first place that in view of the extended experience of the New York Central with electric operation at its New York terminal, Mr. Hustis can speak with large authority on the subject.

At the outset of his testimony Mr. Hastis stated that he did not appear before the committee to oppose electrification, because the question was not whether the railroads should be required to electrify their lines but whether the Boston & Albany R.R. should be required by legislation to incur an annual net loss in its operation of at least half a million dollars a year as the result of such electrification.

Should the legislature decide to require this from the railway company, it must consider what the effect of such legislation would be not only upon the railway company and its property, but upon the public which it serves. We quote further from Mr. Hustis' testimony as follows:

> The railroad recognizes further that certain advantages would accrue to it under electrification. It would, for instance, admit of greater use being made of existing facilities and allow the railroad to expand its suburban service at certain hours of the day, when, under steam operation, the limit of existing facilities has been almost reached. It would be possible also to effect certain economies under electric operation that are not possible under existing conditions. Whether it would add to safety in operation is uncertain, and cannot be determined from the limited experience under electric operation.
>
> To prepare the road, that is, to equip it for electric operation, and remodel the stations, tracks and signals, and to provide the necessary equipment for a proper electric operation for passenger service within the Metropolitan district will cost approximately $6,413,300, after making a very liberal allowance for equipment released. Allowing for the normal increase in travel and for all possible economies under electric operation, it has been carefully estimated that electrification would entail an added net loss in operation of nearly $550,000 per annum.
>
> The gross passenger revenue derived in the district under consideration, including all classes of tickets and the proportion of the revenue on passengers entering and leaving Boston from or for points west of South Framingham, is approximately $1,300,000.

These figures, it is to be noted, are not mere offhand estimates, but were verified by the State Commission of 1911. It should be understood also that these estimates are based on the cost of electrifying the road *for passenger service only*.

It has been proposed that the increased operating expenses should be met by increasing the passenger fares in this district. This would mean, however, that the present fares would have to be raised fully 40%. There is no doubt that the public would not endure such an increase; and further, if it were made, it would defeat its own purpose, for traffic would be diverted to the trolley lines in such an amount that probably the higher fares would yield less revenue than the present fares.

Those who advocate electrification fall back upon the argument that the traffic would be increased thereby; but in order that the company should increase its net passenger earnings sufficient to pay the interest on the investment necessary for electrification, the present volume of passenger traffic would have to be doubled. As Mr. Hustis well says, the posibilities of any such enormous growth in traffic are exceedingly remote.

It should be understood that the estimates above recited cover the cost of electrifying the line for passenger service only. If the company were compelled to electrify all its freight lines as well, the cost would be enormously increased. Mr. Hustis stated that to electrify the Boston & Albany's Grand Junction branch would for the work of grade-crossing elimination alone cost approximately $4,500,000.

In concluding his testimony, Mr. Hustis gave a clear statement of the contrast between the financial condition of his company to-day compared with that of ten or twenty years ago. Since the conditions he recites are true of many other railway companies as well as the Boston & Albany, we quote from his testimony as follows:

> Because the Boston & Albany R.R. was once a prosperous property with ample surplus enabling it to pay 8% and make many expensive improvements from income, it is still assumed that there is no valid reason why it should not continue to do so. It has two principal sources of income, (1) from the transportation of passengers; (2) from the transportation of freight. The balance from mail, express, etc., is relatively small.
>
> The passenger and freight rates have remained practically stationary for the past ten years or more. The rate per passenger mile last year was 1.791c. The rate per ton mile last year was 0.848c. These rates are substantially the same as at the time of the lease to the New York Central in 1900.
>
> Expenses for material and labor have increased tremendously during this period; fuel, for instance, one of the largest single items of expense, being 19% of the total operating expenses, has increased approximately 25% in cost per ton since 1900. Passenger cars, which in 1900 cost $6751, today cost $15,750, an increase of 133%. Freight cars, which in 1900 cost $550, today cost $1025, an increase of 86%. Native ties which in 1900 cost 45c., today cost 65c., an increase of 44%. The cost of lumber has increased about 50%. Passenger locomotives, which in 1900 cost $13,800, today cost $23,700, an increase of 72%. Engine houses for the smaller engines cost $2000 per stall in 1900; today the cost is $7000 per stall, an increase of $150,000 for a thirty-stall house.
>
> While there have been some economies in operation, particularly in the freight service, by reason of the use of heavier power, it has not been at all commensurate with the increase in the cost of equipment. So far as the passenger service is concerned the increased weight of passenger equipment has almost entirely offset the increase in the weight of locomotives.
>
> During this period wages have likewise increased, and this has been particularly true during the past several years when increased wages and improved conditions have resulted in increased compennsation as follows: Engineers, 35%; firemen, 39%; conductors, 34%; trainmen, 42%; yardmen, 54%.
>
> It must be apparent from the foregoing that the operating management of the Boston & Albany is satisfactorily handling a very largely increased traffic at rates which are substantially the same as twelve years ago, and with reasonable expedition, regularity and economy. It has suffered in its operating showing, as have all the railroads, in the enormous increases in expenses, yet its unit costs of operation compare favorably with other roads of similar character. The lessee company has moreover not allowed the yearly deficit since 1906 to stand in the way of appropriating more money for improvements.
>
> It has now reached a point where the volume of business, at the rates which have been in effect for more than a decade, just about enables it to meet its operating expenses, taxes, interest, and rentals, leaving practically no surplus. Any contraction in its volume of business, any reductions in rates, or any additional burdens (such as that proposed by compulsory electrification) would prevent the road from earning its guaranteed rental, and would restore or increase the annual deficit, which on the date of the last report to the Railroad Commission aggregated $5,000,000.

A Huge Piece of Engineering Work

It is probable that no law ever enacted by Congress, not even excepting the act providing for the construction of the Panama Canal, involves a larger amount of engineering work and a larger outlay of money for engineering services than the Railway Valuation Act which became law last week.

Our readers will recall that a number of the states have already undertaken and carried through a valuation of the railway property within the state. We may mention especially the states of Michigan, Wisconsin and New Jersey in which, we believe, the work has been

most thoroughly done. The records of such state appraisals already made will doubtless be utilized to a considerable extent in the appraisal work to be undertaken by the Federal Government. With these exceptions, the work of valuation will have to be done from the beginning; and particularly in the older states, the amount of research and investigation and overhauling of old records that will have to be gone through with to comply with the law's requirements, is nothing less than appalling.

In view of the great importance of this work to engineers, we have reprinted on another page of this issue the act in full as passed by the Senate on Feb. 24 and concurred in by the House of Representatives on Feb. 27. The bill originated in the House (No. 22,593) and was commonly known as the Adamson Bill. In the Senate, however, the bill was practically entirely rewritten. It is stated that this rewriting was done under the personal guidance of Senator La Follette, with the advice of Dr. B. H. Meyer of the Interstate Commerce Commission.

It should be noted in the first place that the act provides not merely for the valuation of railway property, but of the property of every common carrier subject to the Interstate Commerce Law at the present time, or which may hereafter be brought under its jurisdiction. This means, of course, that the property of water carriers and express companies doing interstate business is likewise subject to valuation.

The Commission is authorized to employ such experts and other assistants as may be necessary to make the appraisal required but nothing is said regarding the rates of compensation of such experts. In fact the act carries no appropriation and in order to make it effective an appropriation of $500,000 has been inserted in the General Deficiency Appropriation Bill.

It is particularly noteworthy that the law definitely specifies that the valuation is to be in detail. An inventory of all the property of every common carrier is to be made, and for each and every piece of property there must be ascertained and reported in detail: (1) its original cost and all that has been expended upon it since; (2) the cost at the present time of its reproduction new; (3) the cost of its reproduction less its depreciation.

In obtaining these figures of cost, no haphazard estimate will do, for the law demands specifically that an analysis of the method by which these several costs are obtained must be furnished.

The above refers to the appraisal of the physical property only. The Commission is instructed to ascertain and report separately other values and elements of value if any in the property of each common carrier. This clause refers doubtless to such elements as franchises, good will, etc.

A question as to the right of a public service corporation to earnings on the unearned increment in the value of its real estate holdings is suggested by a clause which requires that the appraisers shall report in detail:

> First, the original cost of all land, rights-of-way and terminals in use at the time they were acquired; secondly, the present value of the same, and, thirdly, the original and present cost of condemnation and damages or other expenditures incurred by the railway in their acquirement in excess of their original cost or present value.

Clause 4 of the law is one which will require, in New England and the Middle States especially, an amount of antiquarian delving into old records that would rival the labors of a genealogist. This clause requires the Commission to investigate the history and organization of the present and any previous corporations operating the property, to report upon any increases or decreases in stocks, bonds or other securities, upon the moneys received by any issues of securities, upon the syndicating, banking and other financial arrangements by which the securities were placed, and finally a blanket requirement that a report shall be made upon the expenditure of all moneys and the purposes for which the same were expended.

Under clause 5, the Commission through its examiners, is to ascertain the amount and value "of any aid, gift, grant of right-of-way, or donation made by any federal, state or municipal government, or by individuals, associations or corporations." Land grants are also to be investigated and the amount of money which any corporation has realized from such land grants to the present time.

The purpose of the requirements in this clause is in no way indicated. Doubtless it is intended to settle the question to what extent the railways and other common carriers actually paid for their present property, on which they are endeavoring to earn dividends, and to what extent they acquired it as a free gift.

The Commission is to begin the appraisal within 60 days after the approval of the act and prosecute the same as rapidly as possible, reporting its progress to Congress at the beginning of each regular session until the work is completed. Railway corporations and others subject to this law are required to furnish as may be required, maps, profiles, contracts, reports of engineers and any other documents, records and papers or copies thereof which may be called for in aid of the work of appraisal. Such corporations must coöperate with and aid the Commission in the work of valuation to such extent as the Commission may order and the Commission is given authority "to enact rules and regulations which will have the full force and effect of law."

The valuation is not merely to be made once and for all, but is to be kept up continuously to date. It is to show, moreover, not only the valuation of the properties of each corporation as a whole, but also the valuation of each corporation's property within the boundaries of each state, so that it will be available for state taxation purposes.

The concluding paragraphs of the act establish a method by which the valuation when made may become final and authoritative as prima-facie evidence in any proceedings before the Interstate Commerce Commission or in any Court. Briefly summarized, when the tentative valuation of the property of any corporation is completed, formal notice will be given to the corporation and also to the Attorney-General of the United States and the Governor of the state in which the property is located. A period of 30 days after such notice is allowed for filing protests against the tentative valuation. In the absence of such protests, the valuation becomes final. In case any protest is filed, proceedings before the Commission to determine the validity of such protest and fix the final valuation of the property are provided for.

It would be difficult to exaggerate the importance of this act, not only to the corporations affected but to the

public. The public is affected not merely because the rates to be charged by railways and other corporations under the law are in future likely to be fixed on the basis of the valuations now provided for; but because the public is first and last the owner of the railways. The stocks and bonds of railways and other corporations affected by this law are held not only by private individuals numbering probably a million or more in this country, but are held also in enormous quantities by insurance companies, savings banks, and other financial institutions holding trust funds. Every man with a savings bank deposit or a life insurance policy, therefore, is vitally interested that the valuation of the railways and other corporations which Congress has ordered shall be a fair and accurate one.

It would be easy to criticize the provisions of the law in detail. It is extremely doubtful, for example, whether the attempt to unearth all the past financial transactions of the corporations is worth the expense it will involve. Because common stock may have been given as a bonus to the people who subscribed for the bonds of a railway built ten, or twenty, or fifty years ago, there would be no justice in saying that the present owners of the stock, which may have changed hands twenty times since its original issue, are not fairly entitled to whatever fraction of value it may represent of the corporation's assets. The law, however, specifically requires this and similar delving into financial and engineering history. We will merely express the hope that the Commission in the exercise of its discretion will place the emphasis in its work on the really important features of the law and not on those which when carried out can serve no useful purpose.

In view of the vital public importance of this great work, it is to be hoped that Congress and the Commission in arranging for its prosecution will see to it that it is placed in the hands of engineers of high standing and that the salaries are fixed at a level high enough to secure the services of such engineers.

It must be said frankly that some of the work which the Interstate Commerce Commission is already prosecuting is falling far short of what it should accomplish in public usefulness and is in fact in great degree wasted because the Commission cannot or will not pay salaries sufficient to secure high-class engineers. It is to be hoped that this error will not be repeated in undertaking the enormous task of valuing the railways in the United States.

It is not to be supposed that the railways and other corporations will sit calmly by and do nothing while appraisal of their properties is being made by the federal authorities. Without doubt they will take measures to duplicate the work the Federal Government is to undertake, so far as the information is not already available in their own records. This means or ought to mean that there should be a very active demand on the part of the railway companies during the next sixty days for the services of every well known engineer who has had experience in valuation work. The railways will undertake this work for their own protection and not by any means to stand in the way of the Commission engaging the services of high-class men, provided it desires to do so and to pay the price. In fact it is distinctly in the interest of the railways that the organization which the Commission creates to carry out this important work shall be made up of the best and most competent men anywhere obtainable. A fair valuation, which will settle questions now in dispute, will be of great public service. A valuation made by incompetent men would work grave injury and would be far worse than worthless.

LETTERS TO THE EDITOR

The Effect of Sugar on Concrete

Sir—In your issue Jan. 16, 1913, p. 126, you ask for information on the effect of cocoanut oil and sugar on concrete.

The dangerous action of sugar has come to our attention very forcibly in two instances.

A few batches of concrete in an otherwise perfect job failed to harden. The sand, gravel and water were normal and the brand of cement used had given exceptionally uniform and high-grade results. Routine tests made on large cargo shipments showed a uniformly high quality. But special tests made on some few sacks left in the mixer shed showed erratic results. Some samples set up hard in a few moments and others failed to harden at all. The manufacturer had kept a complete record of every shipment to this particular job and was positive that every bit of the cement was normal when it left the factory. Finally, after much tracing, it was found that a few sacks of cement had been broken open during loading on the steamer. On unloading, this cement had been swept up and re-sacked. The ship had, on a previous trip, carried a cargo of sugar. Some of the sugar remaining in the hold was swept up with the cement. Examination with a magnifying glass showed grains of sugar mixed with the cement.

On another occasion our field inspector ran short of sample bags. He asked the camp cook to help him out and was given a couple of old sacks. When this batch of samples was tested the cement contained in the bags made from old sacks showed very erratic tests. The rest of the shipment was normal. The test pieces had the peculiar appearance that we had learned to attribute to "sugared cement," so we were suspicious. Correspondence with the cook and field inspector developed the fact that the old sacks had been used to hold sugar, but "had been thoroughly cleaned." Other tests on this same lot of cement showed it to be entirely normal. That inspector will never take a chance with an "old sack" again.

Our tests show that quantities of sugar as small as 0.25% of the weight of the cement will completely kill the set. Larger quantities—1% or 2%—will make the cement quick setting, but will eventually cause the test

pieces to disintegrate. The action is more pronounced with some cements than with others. Dilute sugar solutions completely deflocculate cement when suspended in water. Even the finest-ground cement will settle out like so much fine sand. When test pieces that have been disintegrated by sugar solution are dried, clear crystals —apparently of sugar—can be detected with the aid of a magnifying glass.

We at first thought that this action was due entirely to the formation of calcium saccharate, which is soluble, and so prevents the formation of the calcium silicates and aluminates that are essential to the hardening of cement.

However, in the light of the few preliminary tests, we are inclined to attribute the effect of sugar to some sort of catalytic action; only in this way can we account for the action of such a small quantity of sugar on such a large quantity of cement.

We have more detailed and exact experiments under way. We are determining the action of sugar solution as well as solutions of other saccharides and organic substances on cement of known chemical composition and kiln treatment.

We think that in all probability the peculiar action of some sands and gravels on cement will be finally traced to the existence of some organic catalyzer.

CHAS. A. NEWHALL,
Chemical Engineer.
603-6 Northern Bank Bldg., Seattle, Wash.
Feb. 18, 1913.

The Failure of a Railway Automatic Stop

Sir—On Sept. 4, last, there was a collision on one of the Tube railways of London, as is probably known to many readers of ENGINEERING NEWS, who may also be aware that these lines are protected by automatic signals controlled by track circuits, and that, therefore, such an accident should not have occurred.

The matter has been one that has given no little anxiety to those who, like myself, pin their faith to automatic signaling. Had any weakness in the system been revealed, the future of the rapid-transit facilities of London would have been endangered. As illustrated by the experience of the New York subway, rapid train service is possible only through automatic signals. Another instance may be cited. When the underground lines between South Kensington and the Mansion House station, London, were controlled by signals operated from towers, the maximum service possible was 12 trains per hour. Now, with automatic signals, there are 40 per hour.

The accident in question had one feature that just now has more interest for American railway officials than British, because the former are more concerned over the reliability of automatic stops than we are. Automatic stops are, in London as in New York, part of the equipment of automatic signals and it was the failure of an automatic stop to work properly that contributed to the accident.

Aside, it may be briefly noted that the collision created some interest because of the attitude of the men's brotherhoods toward automatic signals. The men have no love for these new methods, as their adoption displaces towermen. The men have also a grievance against the electric-railway companies in that the latter will not employ a second man in the motorman's cab. Could the brotherhoods then produce evidence to show that automatic signals were unreliable they would have somewhat justified their agitation.

Sir Arthur Yorke, the chief inspecting officer of the Board of Trade, in his report just issued, has stated his opinion that the signals were against the second train, but that the motorman was not paying attention to his duties. He consequently missed seeing the signals and was unaware of any danger until he saw the tail-markers of the first train standing in the station, which he had probably assumed was still 2½ min. ahead of him. It had, however, been delayed by trouble with the motors.

The automatic stop should, of course, have pulled up the train automatically. On inspection half an hour after the accident, the stop was found in its normal, vertical (stop) position. On the connections being closely examined by the signal engineer, it was found that one of the brackets supporting the rocking shaft which carries the arm was loose. It is, therefore, assumed that the stop would work sluggish—as it is restored to the vertical position by a spiral spring and not by power. By the time the second train passed, evidently it had not resumed the full vertical position following the signals going to danger behind the first train. But it did so afterward, as found on inspection after the collision.

All the alleged failures mentioned by the trainmen in their campaign have been investigated, and while there have been some cases (not more than half a dozen, most likely) of signals being at clear when they should have been at danger, yet in all these cases, except one, the automatic stop remained working normally and the train was stopped. There has been one case where both signal and stop remained at clear when they should have gone to danger, and this was caused through the greakage of the copper bond-wires of the track circuits. In those days the bonds were rigid and broke easily; now they are flexible and similar failures are not expected in future. The number of cases of signals failing to "clear" is estimated at one in every 315,000 movements, and it is calculated that on the three Tube railways of the London Electric Railways Co. (which do not include the Metropolitan Railway or the District Railway) there are 240,000 signal movements every day.

H. RAYNOR WILSON.
96 Hurlingham Road, London, S. W., England,
Feb. 12, 1913.

[It is evident, from the foregoing mention of Sir Arthur Yorke's report on the South Kensington line accident, that the inspection and maintenance of signal apparatus was open to sharp criticism if it was allowed to get in such dilapidated condition. Moreover, the design of the automatic stop and signal control seems radically wrong, judged by American standards; with spring actuation instead of gravity (counterweight) an added chance of failure is included, and the failure of a track circuit should, in itself, set the signals at danger.—ED.]

NOTES AND QUERIES

Erratum. In the table of performance of rock channelers on p. 410 of our issue of Feb. 27, the third column gives the work done by three single machines, instead of by two, as stated in the heading.

Midwinter Convention of the American Institute of Electrical Engineers

There have been criticisms of inadequacy made against the standardization rules of the American Institute of Electrical Engineers (regulating largely the testing and rating of power apparatus) as they relate to recent progress. Therefore, opportunity was taken to utilize the midwinter meeting, February 26, 27 and 28, for the discussion of these shortcomings, and 44 papers were prepared under the auspices of the Standards Committee. With such a formidable program it was necessary to eliminate all entertainment features (with the exception of a reception and ball after the meetings were all over). The papers were bunched in related groups and presented in abstract The discussions were mostly on these groups and related general topics.

NEW POWER UNIT—There were three matters of moment having to do with testing and rating though extraneous to the organized program. First, comments were made by H. G. Stott, of the Interborough Rapid Transit Co., New York City, upon the use of the "myriawatt," the proposed unit of power input to steam prime movers which, as noted in ENGINEERING NEWS, Jan. 30, 1913, is intended to supplant the convenient fiction "boiler horsepower." Mr. Stott reported that considerable criticism has been aroused over the proposition to institute use of the myriawatt, but that he believed it had risen from misconception of the intention of the Standards Committee in making such a proposition. They had not in reality formulated any new unit, but had put together older terms expressing the amount of power represented by 10 kw., which fortunately for their purposes was equal, within 2%, to the old boiler horsepower.

The action in endeavoring to secure the adoption of convenient units was intended to be the entering wedge for use of the metric system in measurements of mechanical power. The next step contemplated was the exclusive use of the centigrade thermometer, a convenience which was at once apparent to anyone who had ever made any extended calculations involving the odd 32° of this English scale. Whereas once it was common and permissible practice to specify the requirements of prime movers in pounds of steam, now the situation had changed with the introduction of superheat so that it was necessary to use some energy basis of rating.

Mechanical engineers and electrical engineers, he claimed, are now so closely allied that it was often impossible, as in steam-turbine electric-power plant work to separate for test the fundamental parts of the equipment units. It was his experience that the use of the centigrade degree, the kilogram and the calorie would prove no barrier to easy work in mechanical and steam engineering, though there would be a great deal of opposition to their introduction on account of their lack of familiarity to the working man in particular.

C. P. Steinmetz, of Schenectady, stated that he had secured accuracy and efficiency in all his work by using the metric system entirely for all computations and, when final results were secured, by transforming them into English units if necessary. H. M. Hobart, of Schenectady, had found the discrepancy in English and American tons the great stumbling block of the British system of units. B. G. Lamme, of Pittsburgh, called attention to the practice in machine design where a decimal system of linear units was practically used (with inches and tenths, or tens and hundreds). In research work where a multiplicity of units arose, of weight, thermal capacity, etc., this simple situation did not exist and it was necessary to go completely to the metric system or else work under the handicap of many mathematical transformations.

EFFECT OF HEAT ON INSULATION—The second related but unclassified matter was a paper by C. P. Steinmetz, of Schenectady, and B. G. Lamme, of Pittsburgh (comprising a sub-committee on revision of rules), entitled "Temperature and Electrical Insulation." They divided insulating materials into three groups according to their heat-resisting properties (Class A, paper, cotton and other fibrous materials, natural oils, resins and gums, etc.; Class B, mica, asbestos, etc., alone and in combination with binding materials where deterioration of the latter worked no harm; Class C, truly fireproof materials). They recommended a maximum ultimate insulation temperature of 100° C. for the first class with a permissible rise of apparatus temperature in service of 50°. For the second class this interior temperature limit was set at 150° C. with a permissible general apparatus rise of 85. An exception was noted in Class A insulation for railway motors, where the authors admitted the economy of higher temperatures (65° rise) on account of peculiar space and weight limitations of railway service.

RATINGS—The third detached matter was seen in the paper, "Method of Rating Electrical Apparatus," by W. L. Merrill, of Schenectady, W. H. Powell, of Milwaukee, and Charles Robbins, of Pittsburgh (constituting a subcommittee on rating). They presented several general, sweeping and (in some cases) debatable recommendations; (I) that all electrical apparatus be rated by output and that this be expressed in kilowatts (or kilovolt-amperes for alternating current) whether it be electrical or simple mechanical power output; (II) that service ratings be divided into two main classes (A) where stationary temperatures would be reached and (B) where not, with three subdivisions under each class for (1) constant, (2) periodic and (3) pulsating loads; (III) that the rating express the maximum safe capacity without allowance for overloads exceeding 60 seconds; (IV) that the name plate carry an Institute inscription showing the class rating and such equivalent shop test as would impose as severe conditions as the expected service, (for instance, "A. I. E. E.—B 2—EQUIV. TEST. 30 HP. 1 HR.") The most serious objections raised to these proposals related to the elimination of overload capacity. Prof. W. B. Crocker (supported by S. S. Wheeler, Philip Torchio and others) characterized this as providing negative factors of safety, since the temperatures to be attained would produce actual depreciation of insulation. It was like rating the load on a bridge, he stated, beyond the elastic limit of the steel in it. Moreover such ultimate capacity ratings meant that under unexpected conditions a machine would fail and the net result would be poor service by the makers. For every sale, an intimate knowledge of all the operating conditions would have to be acquired, and under stress of sharp competition the salesman would fail to allow any margin for contingencies.

Invitations were extended to other associations to contribute expressions of opinion on the proposed ratings for the study of the Standards Committee.

TEMPERATURE AND HEAT LOSSES—The formal program showed four groups of papers; (1) Heat Measurements and Rating by Temperature; (2) Determination of Machine Losses; (3) Methods of Testing for Machine Performance; (4) Miscellaneous Topics Relating to Rating.

One portion of the first group related particularly to moving machines and included "Notes on Internal Heating of Stator Coils," by R. B. Williamson, of Milwaukee; "Measurement of Temperature on Rotating Machines," by L. W. Chubb, E. I. Chute, and O. W. A. Oetting, of Pittsburgh; "Determining Temperature of Alternating Current Machines," by H. G. Reist and T. S. Eden, of Schenectady; and "Thermo-Couples and Resistance Coils for Determination of Local Temperatures," by J. A. Clapp and L. T. Robinson, of Schenectady.

A second sub-group took up transformer work particularly, comprising "Determining Temperatures of Transformers and of Cooling Medium," by S. E. Johannesen and G. W. Wade, of Pittsfield, Mass.; "Measuring Temperature of Transformers," by C. Fortescue and W. M. McConahey, of Pittsburgh, and "Correction of Transformer Temperature for Variation of Room Temperature, Taking Account of Both Copper and Iron Losses," by C. Fortescue, of Pittsburgh.

A third sub-group of five papers took up prediction of expected temperature rise of stationary apparatus under departure from standard conditions, and the laws of heat transfer. They included: "Temperature Rise of Stationary Induction Apparatus as Influenced by Temperature, Pressure and Humidity of Cooling Medium," by J. J. Frank and W. C. Dwyer, of Pittsfield; "Effect of Room Temperature on Temperature Rise of Motors and Generators," by W. M. Day and R. A. Beekman, of Schenectady; "Effect of Air Temperature, Barometric Pressure and Humidity on Temperature Rise," by C. E. Skinner, L. W. Chubb and Phillips Thomas, of Pittsburgh; "Laboratory Investigation of Temperature Rise," by C. H. Blanchard and C. T. Anderson, of Mansfield Ohio; "Laws of Heat Transmission," by Irving Langmuir, of Schenectady.

The first three of these papers showed the limitations of the present Institute rules for corrections and presented test results indicating what substitutes were advisable. The fourth and fifth papers dealt with the more general fundamental problems of radiation, conduction and convection; the fourth described studies to expose the variations of heat transfer with variations of pressure, temperature, and humidity of air. Mr. Langmuir had a very ambitious presentation of all the data (original and compiled) which his work had shown to be reliable. The various expressions for the three methods of heat transfer were reviewed, as to their utility, and special attention given to the development of a satisfactory calculation of convection loss from various surfaces. He argued for that method which considers the natural convection effect to be the same as if a definite adherent film of gas acted by conduction. (See ENGINEERING NEWS, July 4, 1912, p. 38.)

In the fifth sub-group, "Current Rating of Electric Cables," by R. W. Atkinson, of Pittsburgh, and H. W. Fisher, of Perth Amboy, N. J. and "Heating of Cables," by Saul Dushman, of Schenectady, temperature limits to current capacity were discussed with formulas for precalculation.

MACHINE LOSS DETERMINATION—The second main group of related papers discussed methods of determining losses in apparatus. There was a still further subdivision, the first item of which covered induction motors with the papers, "Induction Motor Load Losses," by H. G. Reist and A. E. Averrett, of Schenectady; "Stray Losses in Induction Motors," by A. M. Dudley, of Pittsburgh, and "Notes on Induction Motor Losses," by R. W. Davis, of Milwaukee. These papers discussed those "extra" losses which appear in some machines under load. The need was expressed of fixing on some empirical relations with quantities more easily measured and without need of actually imposing full load. A second subdivision showed studies of these same "load" losses in transformers, the papers being "Losses in Transformers," by W. W. Lewis, of Pittsfield, and "Stray Losses in Transformers," by C. Fortescue and W. M. McConahey, of Pittsburgh.

"Load" losses in generators were discussed in the papers, "Determination of Load Loss Correction Factors for Rotating Machines," by E. M. Olin and S. L. Henderson, of Pittsburgh; "Load Losses of Alternating Current Generators," by W. J. Foster and E. Knowlton, of Schenectady; "Notes on Stray Losses in Synchronous Machines," by F. K. Brainard, of Milwaukee; "Stray Losses in Direct-Current Commutating Machines," by H. F. T. Erben and H. S. Page, of Schenectady; "Determination of Stray Losses from Input-Out put Tests," by L. T. Robinson, of Schenectady; "Errors in Efficiency Determinations," by E. I. Chute and William Bradshaw, of Pittsburgh; "Brush Friction and Contact Losses," by H. F. T. Erben and A. H. Freeman, of Schenectady; "Determining Brush Losses," by H. R. Edgecomb and W. A. Dick, of Pittsburgh, and "Commutation and Brush Losses," by C. E. Wilson, of Pittsburgh.

TESTS FOR PERFORMANCE—The third main group presented studies of finding before shipment the temperatures which large alternating-current machines would attain under normal operation. The papers were: "Comparison of Methods of Loading Large Generators and Converters for Factory Temperature Test," by F. D. Newbury, of Pittsburgh; and "Comparison of Methods of Making Load Tests on Generators and Induction Motors," by A. M. Dudley, of Pittsburgh.

On account of lack of, and cost of, an unlimited power supply to test large machines under full load at the shop, it is necessary to run the machine under artificial conditions which develop full-load internal losses. Four types of such tests were discussed at the sessions where the foregoing papers were read: (1) "Open- circuit" loading with over-excited fields giving excess armature voltage and core loss to compensate for lack of armature current; (2) "short-circuit test" with the armature short circuited and the fields excited only enough to give the normal full-load current; (3) the "open-delta direct-current" scheme where the fields are fully excited but the armature windings have some delta or rectangle arrangement of the windings with one corner open and full-load value of direct current fed in; (4) the "zero-power-factor" test in which duplicate equipment to the generator under test has to be available, and the two are driven in parallel with the fields of the one over excited and the fields of the other under excited until full-load armature current flows.

In the general discussion B. G. Lamme, of Pittsburgh, called attention to the place of these "compromise" tests in the general field of electrical testing. As he would classify such effort, there would be four kinds of tests, (1) for the designer to study, (2) to satisfy the manufacturer that the specifications would be fulfilled, (3) witness tests to show a purchaser that a machine would meet load conditions, and (4) routine tests on large numbers of duplicate machines where a few data obtained and compared with results of the first class of tests showed if each individual machine was satisfactory. Groups 2 and 3, he stated, ought to give the same results, but did not always; it was the desire of the Standards Committee to show compromise tests which would be accepted for groups 1 and 2, noting the probable sources of error.

The discussion in general favored the "zero-power-factor" test where the necessary equipment was available; otherwise a combination of the "open-circuit" and closed-circuit" schemes—there being alternate periods of each so calculated that total losses secured in each part of a machine were equal to those there in normal operation.

In regard to testing induction motors, the general opinion was that various compromise tests had shown close agreement with true full-load tests and were desirable. The scheme most preferred seemed to be the "reverse-rotation," in which the motor is driven at full speed in reverse direction while the impressed voltage (reduced) is adjusted to give the full-load stator current.

Analogous schemes for testing large transformers were presented in the papers, "Load Tests on Transformers," by J. J. K. Madden, and "Sources of Error in Transformers Tests," by W. M. McConahey and C. Fortescue, of Pittsburgh.

Miscellaneous Subjects—In this fourth subdivision of the program came the papers on oil switches, spark gaps, wave forms (of alternating-current generators), and regulation as follows: "Rating Oil Circuit Breakers," by G. A. Burnham, of Boston; "The Sphere Spark Gap," by W. S. Farnsworth and C. Fortescue; "Calibration of the Sphere Gap," by L. W. Chubb and C. Fortescue; "Potential Waves of Generators," by W. J. Foster, of Schenectady; "Wave Form Distortions and Their Effect," by P. M. Lincoln, of Pittsburgh; "A Proposed Wave-Shape Standard," by C. M. Davis, of Schenectady; "Experimental Regulation of Alternators," by A. B. Field, of Pittsburgh; "Regulation of Definite Pole Alternators," by S. H. Mortensen, of Milwaukee; and "Generator and Prime Mover Capacities," by D. B. Rushmore and E. A. Lof, of Schenectady.

In regard to circuit breakers, it was brought out that rating for the safe circuit voltage, temperature rise and tripping value of current was no longer sufficient, since systems had grown so large that opening a switch often meant intense concentration of energy and wrecking of the mechanism. The trend of opinion was that it would be satisfactory to state the maximum kilovolt-amperes under which a switch would safely open—being the normal circuit voltage times the current for which it would trip.

The old needle spark gap (for measuring voltages) has been found too cumbersome and unreliable for the high voltages which have come into service since the Institute standardization rules were formulated. Sphere gaps have supplanted them, as was outlined in the papers mentioned, for above some 35,000 volts.

The proposal of C. M. Davis in the paper noted met with approval for the most part. He would substitute for the present rule of "maximum permissible deviation of wave from sinusoidal shape not exceeding 10%" a so called "distortion-ratio" of the given wave to one of sine shape. The determination of this is a simple measurement of the change of reactance of a condenser for the change in wave shape, involving the use of only simple standard instruments.

The Railway Valuation Act

The bill providing for valuation of the railway of the United States and of the property of other corporations subject to the Interstate Commerce law passed the Senate on Feb. 24 and the House of Representatives on Feb. 27. As the law orders the undertaking of a vast work, most of which will have to be done by engineers, its full text is printed below. A summary of the act and comment upon it is given in our editorial columns.

Be it enacted etc. That the Act entitled "An Act to regulate commerce," approved Feb. 4, 1887, as amended, be further amended by adding thereto a new section, to be known as Section 19a, and to read as follows:

"Sec. 19a. That the commission shall, as hereinafter provided, investigate, ascertain, and report the value of all the property owned or used by every common carrier subject to the provisions of this Act. To enable the commission to make such investigation and report, it is authorized to employ such experts and other assistants as may be necessary. The commission may appoint examiners who shall have power to administer oaths, examine witnesses, and take testimony. The commission shall make an inventory which shall list the property of every common carrier subject to the provisions of this Act in detail, and show the value thereof as hereinafter provided, and shall classify the physical property, as nearly as practicable, in conformity with the classification of expenditures for road and equipment, as prescribed by the Interstate Commerce Commission.

"First. In such investigation said commission shall ascertain and report in detail as to each piece of property owned or used by said common carrier for its purposes as a common carrier, the original cost to date, the cost of reproduction new, the cost of reproduction less depreciation, and an analysis of the methods by which these several costs are obtained, and the reason for their differences, if any. The commission shall in like manner ascertain and report separately other values, and elements of value, if any, of the property of such common carrier, and an analysis of the methods of valuation employed, and of the reasons for any differences between any such value, and each of the foregoing cost values.

"Second. Such investigation and report shall state in detail and separately from improvements the original cost of all lands, rights of way, and terminals owned or used for the purposes of a common carrier, and ascertained as of the time of dedication to public use, and the present value of the same, and separately the original and present cost of condemnation and damages or of purchase in excess of such original cost or present value.

"Third. Such investigation and report shall show separately the property held for purposes other than those of a common carrier, and the original cost and present value of the same, together with an analysis of the methods of valuation employed.

"Fourth. In ascertaining the original cost to date of the property of such common carrier the commission, in addition to such other elements as it may deem necessary, shall investigate and report upon the history and organization of the present and of any previous corporation operating such property; upon any increases or decreases of stocks, bonds, or other securities, in any reorganization; upon moneys received by any such corporation by reason of any issues of stocks, bonds, or other securities; upon the syndicating, banking and other financial arrangements under which such issues were made and the expense thereof; and upon the net and gross earnings of such corporations; and shall also

ascertain and report in such detail as may be determined by the commission upon the expenditure of all moneys and the purposes for which the same were expended.

"Fifth. The commission shall ascertain and report the amount and value of any aid, gift, grant of right of way, or donation, made to any such common carrier, or to any previous corporation operating such property, by the Government of the United States or by any State, county, or municipal government, or by individuals, associations, or corporations; and it shall also ascertain and report the grants of land to any such common carrier, or any previous corporation operating such property, by the Government of the United States, or by any State, county, or municipal government, and the amount of money derived from the sale of any portion of such grants and the value of the unsold portion thereof at the time acquired and at the present time, also, the amount and value of any concession and allowance made by such common carrier to the Government of the United States, or to any State, county, or municipal government in consideration of such aid, gift, grant, or donation.

"Except as herein otherwise provided, the commission shall have power to prescribe the method of procedure to be followed in the conduct of the investigation, the form in which the results of the valuation shall be submitted, and the classification of the elements that constitute the ascertained value, and such investigation shall show the value of the property of every common carrier as a whole and separately the value of its property in each of the several States and Territories and the District of Columbia, classified and in detail as herein required.

"Such investigation shall be commenced within 60 days after the approval of this Act and shall be prosecuted with diligence and thoroughness, and the result thereof reported to Congress at the beginning of each regular session thereafter until completed.

"Every common carrier subject to the provisions of this Act shall furnish to the commission or its agents from time to time and as the commission may require maps, profiles, contracts, reports of engineers, and any other documents, records, and papers, or copies of any or all of the same, in aid of such investigation and determination of the value of the property of said common carrier, and shall grant to all agents of the commission free access to its right of way, its property, and its accounts, records, and memoranda whenever and wherever requested by any such duly authorized agent, and every common carrier is hereby directed and required to coöperate with and aid the commission in the work of the valuation of its property in such further particulars and to such extent as the commission may require and direct, and all rules and regulations made by the commission for the purpose of administering the provisions of this section and section twenty of this Act shall have the full force and effect of law. Unless otherwise ordered by the commission, with the reasons therefor, the records and data of the commission shall be open to the inspection and examination of the public.

"Upon the completion of the valuation herein provided for the commission shall thereafter in like manner keep itself informed of all extensions and improvements or other changes in the condition and value of the property of all common carriers, and shall ascertain the value thereof, and shall from time to time revise and correct its valuations, showing such revision and correction classified and as a whole and separately in each of the several States and Territories and the District of Columbia, which valuations, both original and corrected, shall be tentative valuations and shall be reported to Congress at the beginning of each regular session.

"To enable the commission to make such changes and corrections in its valuations of each class of property, every common carrier subject to the provisions of this Act shall make such reports and furnish such information as the commission may require.

"Whenever the commission shall have completed the tentative valuation of the property of any common carrier, as herein directed, and before such valuation shall become final, the commission shall give notice by registered letter to the said carrier, the Attorney General of the United States, the governor of any State in which the property so valued is located, and to such additional parties as the commission may prescribe, stating the valuation placed upon the several classes of property of said carrier, and shall allow thirty days in which to file a protest of the same with the commission. If no protest is filed within 30 days, said valuation shall become final as of the date thereof.

"If notice of protest is filed, the commission shall fix a time for hearing the same, and shall proceed as promptly as may be to hear and consider any matter relative and material thereto which may be presented in support of any such protest so filed as aforesaid. If after hearing any protest of such tentative valuation under the provisions of this Act the commission shall be of the opinion that its valuation should not become final, it shall make such changes as may be necessary, and shall issue an order making such corrected tentative valuation final as of the date thereof. All final valuations by the commision and the classification thereof shall be published and shall be prima facie evidence of the value of the property in all proceedings under the Act to regulate commerce as of the date of the fixing thereof, and in all judicial proceedings for the enforcement of the Act approved Feb. 4, 1887, commonly known as 'the Act to regulate commerce,' and the various Acts amendatory thereof, and in all judicial proceedings brought to enjoin, set aside, annul, or suspend, in whole or in part, any order of the Interstate Commerce Commission.

"If upon the trial of any action involving a final value fixed by the commision, evidence shall be introduced regarding such value which is found by the court to be different from that offered upon the hearing before the commission, or additional thereto and substantially affecting said value, the court, before proceeding to render judgment shall transmit a copy of such evidence to the commission, and shall stay further proceedings in said action for such time as the court shall determine from the date of such transmission. Upon the receipt of such evidence the commission shall consider the same and may fix a final value different from the one fixed in the first instance, and may alter, modify, amend or rescind any order which it has made involving said final value, and shall report its action thereon to said court within the time fixed by the court. If the commission shall alter, modify, or amend its order, such altered, modified, or amended order shall take the place of the original order complained of and judgment shall be rendered thereon as though made by the commission in the first instance. If the original order shall not be rescinded or changed by the commission, judgment shall be rendered upon such original order.

"The provisions of this section shall apply to receivers of carriers and operating trustees. In case of failure or refusal on the part of any carrier, receiver, or trustee to comply with all the requirements of this section and in the manner prescribed by the commission such carrier, receiver, or trustee shall forfeit to the United States the sum of $500 for each such offense and for each and every day of the continuance of such offense, such forfeitures to be recoverable in the same manner as other forfeitures provided for in section 16 of the Act to regulate commerce.

"That the district courts of the United States shall have jurisdiction, upon the application of the Attorney General of the United States at the request of the commission, alleging a failure to comply with or a violation of any of the provisions of this section by any common carrier, to issue a writ or writs of mandamus commanding such common carrier to comply with the provisions of this section."

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An Exhibition Roadway is being built at Olympia, Wash., by paving companies operating in the State. Each company lays a sample of paving at least 100 ft. long and 16 ft. wide in accordance with specifications which it files with the State Highway Department. The road chosen for paving is just outside the city limits and part of a main highway north and south through the state. The Olympia Chamber of Commerce has sent invitations to every city council and board of county commissioners in the State inviting them to inspect the new pavements after they have been laid and subjected to traffic. An act is pending under which the State will spend $8,000,000 on road construction during the coming year.

The Elliott Cresson Medal Awards, made annually by the Franklin Institute of Philadelphia, Penn., for notable achievements in scientific and engineering work, were made this year to the following prominent scientists:

Charles Proteus Steinmetz, Schenectady, N. Y., for successful application of analytical methods to the solution of numerous problems of first practical importance in the field of electrical engineering.

Emile Berliner, Washington, for important contributions to telephony and to the science and art of sound reproduction.

Isham Randolph, Chicago, for distinguished achievement in the field of civil engineering.

John William Strutt (Baron Rayleigh), Witham, Essex, England, for extended research of signal importance in physical science.

Sir William Ramsay, London, for numerous discoveries in the science of chemistry.

Emil Fischer, Berlin, Germany, for numerous contributions of fundamental importance to the science of organic and biological chemistry.

A Footway Tunnel in New York City

A footway tunnel 920 ft. long has just been completed by the City of New York to afford an entrance from Broadway to the new 191st St. station of the west, or Broadway, branch of the present Interborough subway.

When first built, the subway in passing under Fort George Hill had no station between 181st St. and Dyckman St., a distance of nearly one mile. On account of the present and prospective growth of population midway between these two stations, it was decided some years ago to compel the Interborough company to build a new station at 191st St. Coincident with this construction a tunnel was projected, leading from the station, which is at 191st St. and St. Nicholas Ave., practically due west to 191st St. and Broadway. This tunnel construction was carried out under the regular assessment principle, that is, the property benefited by the construction of the tunnel was assessed for the cost, and the tunnel was designed and constructed under the direction of the Borough Government of Manhattan. The entire line is built in easement, no property being purchased by the city.

The 191st St. station of the subway is some 100 ft. below the surface, and is reached by elevators from the street above. The hill underneath which it passes, however, slopes down sharply to the west, so that a tunnel could be built from Broadway some 900 ft. to the west, to the station approach with a down grade toward the station of 1%. This tunnel is some 15 ft. below grade at Broadway and is approached by a double flight of steps. It is straight for practically its entire distance, turning on a right angle curve to enter the station. It is for foot passengers only, is 12 ft. wide, and has a section with 6 ft. sides crowned with a semi-circular 12 ft. arch. It was driven for its entire length through solid rock, and lined with a minimum of 6 in. of plain concrete. The floor is paved with a slight crown with the regular granolithic concrete pavement. The Broadway portal of the tunnel is at present at a vacant lot but the owner has in prospect the erection of an apartment house which will rise above, though it will not have an entrance to the tunnel.

In the construction considerable trouble was encountered with water. The stations at 181st St. and 191st St. have both been subject to considerable infiltration of water, which has many times caused trouble in the operation of the subway. These stations have, however, been protected by waterproofing so that they are reasonably watertight. It was decided that the present use of the footway tunnel was so small that it would not pay to attempt to waterproof the sides. In consequence, the abundance of ground water in the rock has given no end of trouble in penetrating through the concrete side walls. Frequent drains in the side walls leading to longitudinal drains under the tunnel were provided in the design, and further drainage of the same sort actually built. These drains have taken care of a considerable amount of water, but there is still leakage through the walls and roof. Until there is a much larger traffic through the tunnel, however, no further effort will be made to stop this leakage.

The tunnel is lighted with incandescent bulbs in the roof, connected to the regular city lighting system. These lights, of course, have to be kept in service for 24 hours a day. The supervision of the tunnel has been placed under the police department just as though it were a city street; in fact it is known in the city departments as "Tunnel St." As this 800 ft. straight away length might afford an admirable place for the "hold-up" man, it is thought that the police department will have to keep a policeman on "peg post" there most of the time.

The tunnel was built under the direction of the Consulting Engineer to the Borough President of Manhattan, E. P. Goodrich, and was under the special supervision of C. E. Gregory, Mr. Goodrich's assistant. It was built by the Bell-Ross Contracting Co. The contract price was $72,260. It is scheduled to be opened formally on March 8, 1913.

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Standard Specifications for Drain Tile

A committee, consisting of Prof. A. Marston, Seth Dean and W. B. Warrington, has just presented to the Iowa State Drainage Association a "Standard Specification for Drain Tile," which is being printed for free distribution by the Engineering Experiment Station, Iowa State College, Ames, Iowa, and a copy may be had by writing to Director A. Marston, at Ames. The specification is too lengthy to reprint here but we give below the statement of the committee in presenting it.

We beg leave to submit for adoption a set of tentative standard specifications for drain tile, for sewer pipe, and for pipe laying. There is great need for the immediate adoption of such a tentative set of standard specifications, for the guidance of engineers, manufacturers and purchasers.

There can be no doubt that there are miles of cracked drain tile of large sizes in the ground in Iowa. New instances are constantly coming to light. Engineers who have believed their deep drains absolutely sound are constantly finding, to their chagrin and alarm, that many of the large pipes are cracked Collapses of cracked pipe have already occurred in numerous instances, and, while most of the cracked pipe will probably continue to stand up, in a more or less precarious condition of stability, we must remember that few, if any, of the large tile drains of Iowa have yet been called upon to carry floods as great as they will certainly experience in the future. We can look forward only with serious misgivings to what is likely to happen to large cracked tile drains when they are called upon, as they almost certainly will be, to carry floods which fill them more than full.

Our specifications are intended to obviate the danger of cracked pipe in ditches. We have based them largely upon the data of Bulletin No. 31, of the Engineering Experiment Station at Ames, which gives about 175 pages of data, collected in six years of experimental investigations.

To obviate the danger of cracked pipe in ditches will necessarily require a greater cost of construction than present practice, but we earnestly believe the additional expenditure to be wise, and even essential. Drain tile and sewer pipe of large sizes are generally too weak, as at presnt manufactured, to be safe against cracking in ditches of any considerable depth. We have so worded our specifications as to give the pipe contractor the option of furnishing stronger pipe, or of bedding the pipe in concrete, in the deeper parts of the ditch. The cost will be greater than for present pipe in either case.

We have specified much greater care in pipe laying than at present prevails in tile drain construction, and many will object that the resulting increased cost will make it impracticable to enforce the more rigid requirements we lay down. Nevertheless we believe that the vital interests of those who are paying the heavy costs of drainage in Iowa imperatively require safe, reliable and enduring construction, and that it is both wise and necessary that the better methods be adopted.

Of course, both the pipe manufacturer and the pipe-laying contractor must be paid fairly whatever increased cost may be necessary to secure good safe work, and this is contemplated in our recommended specifications. It will be the duty of engineers to enforce faithfully whatever fair specifications may be found necessary to insure good, safe construction.

We acknowledge, with much gratitude, valuable assistance from several drainage engineers and pipe manufacturers. We have modified our first draft materially at their suggestion.

The Accident to the Foundations of the Pearl Harbor Dry Dock

In response to our request, Rear Admiral H. R. Stanford, Chief of Bureau of Yards and Docks, U. S. N., has forwarded to us an account of the blowout that recently occurred in the coffer-dam being used in constructing the foundations of the new naval dry dock at Pearl Harbor, near Honolulu, Hawaii. The design of this dock was described in ENGINEERING NEWS, Dec. 9, 1909, p. 636. The official statement follows:

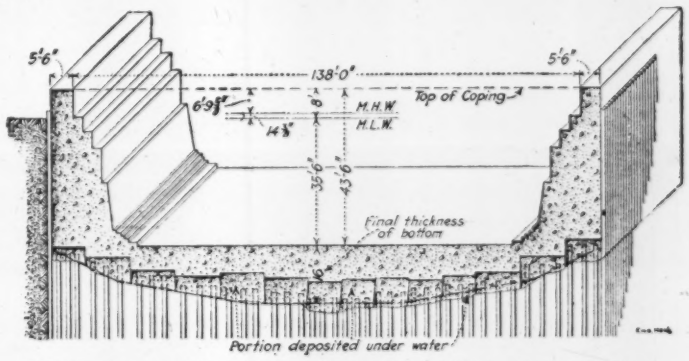
Advice received at the Navy Department, February 17, 1913, from the Naval Station, Pearl Harbor, contained startling information of an accident that day in connection with the construction of the 1000-ft. dry dock which is being built at a cost of about $3,400,000. The accident occurred at a time when the coffer-dam surrounding a portion of the work was pumped free of water, and consisted in the upheaval of a portion of the concrete seal which had been placed in the bottom of the section. The upheaval of the bottom caused the destruction of the crib bracing, thereby permitting the sheet piling to yield and the caving in of the surrounding earth. Later information from the naval station gave further particulars, and stated that the piling in the portions of the work adjacent to that in which the accident occurred showed no signs of movement, which would indicate that there was no general disturbance in the supporting strata or conditions that would preclude the carrying on of the work. Considerable time will be required for a careful examination, due to the large amount of timber wreckage which will first have to be removed.

After practically completing the necessary excavation for the work, the area to be occupied by the dock was surrounded by a coffer-dam of interlocking sheet piling composed of timbers from 70 to 80 ft. in length. For convenience in his operations, the contractor divided the length of the coffer-dam into five sections by cross walls or bulkheads, thus forming compartments, each about 148 ft. wide by 200 ft. in length, the surrounding walls of which were supported or braced by means of interior cribbing. The bottom of the dock will be supported on piles spaced about 3x4 ft., driven to a depth of about 30 ft. Before pumping out the coffer-dam it was necessary to place a mass of concrete on the bottom by the underwater method to provide a bottom water seal.

The concrete in the bottom of the finished structure will have a thickness of 16 ft. on the center line, slightly reducing in thickness to the side lines which support and carry the massive side walls of the structure. This mass of concrete is required for a proper factor of safety to resist the hydrostatic pressure which will be exerted upon the bottom of the dock, and to give the structure the necessary strength and stability after completion. It has been estimated by the contractor that if the lower 8 ft. of this bottom concrete were first placed under water, embedding the heads of the supporting piles, there would be resistance sufficient to permit of the temporary pumping out of the coffer-dam for a period sufficiently long to enable him to complete the concrete in the section. Under favorable conditions, then, the unit cost would be greatly reduced as compared with the unit cost for the concrete previously placed under water. The work proceeded on this assumption, and the accident which has been reported was probably due to insufficient thickness of the bottom concrete during this constructive stage. That this assumption was very nearly justified is proved by the fact that the section was actually pumped dry and that there was no immediate failure of the bottom; had there been a slightly greater thickness in his lower mass there would, in all probability, have been no failure. The above conditions are illustrated by the accompanying sketch showing a typical section of the dock.

The upheaval of a portion of the concrete in the bottom of Section 2 permitted an inflow from the adjacent sections, with the result that the bracing in these sections was distorted, probably leading to the buckling or yielding of this bracing and the removal of the support from the surrounding walls of the coffer-dam.

There will undoubtedly be some delay in the prosecution of this work, due to this accident, but it is hoped the contractor will be able to quickly remedy the damage and continue with his operations. Actual conditions, however, can only be determined by careful examination which will be made as the removal of the wreckage will permit.



PERSPECTIVE SKETCH, SHOWING METHOD OF CONSTRUCTING PEARL HARBOR DRY DOCK

A difficulty which was experienced about one year ago, resulted from the inferior quality of concrete which had been deposited under water, a condition due to the very difficult method which has to be followed in placing the concrete; this difficulty was successfully overcome by careful examinations and experiments, as has been proved by the fact that reports relative to the recent accident advise that the concrete in the bottom was of excellent quality.

[A Honolulu paper which has just come to hand shows a view of the dock wreckage, indicating an area of collapse much greater than the one section noted above.—ED.]

Two New Trains have been built for the New York, New Haven & Hartford R.R. to run as the Merchants' Limited, in five-hour express service between New York and Boston. Each train consists of six steel cars exclusive of the diners. There are four parlor cars, a combination parlor and baggage, and an observation smoker. The usual drawing room has been eliminated, giving 36 chairs instead of 28. The chairs are of a new type with adjustable back. The interior lighting of the cars is unique in railway service, being by what is known as the indirect system with light reflected from the ceiling. Each car contains a dozen bronze domes suspended inverted and containing a 100-watt lamp whose light is projected upward against a white ceiling. Each car carries its own lighting system, comprising an axle generator and a storage battery of capacity to light the car for ten hours. The cars are heated with direct steam radiation and have a positive system of ventilation. The lavatories have a new lock system, permitting use even when standing in stations.

NOTES FROM THE ENGINEERING SCHOOLS

HARVARD UNIVERSITY—A donation of $50,000 has been received from Harriet Otis Cruft to be used for a high-tension electrical laboratory, which will be in the Cruft Memorial Hall.

UNIVERSITY OF GEORGIA—A special road school was held under the auspices of the Good Roads Department of the University on Feb. 10 to 15, inclusive. This school was reported to be the logical development of this Department's work in acting as a clearing house for information gathered from all parts of the state and also from beyond its borders.

KANSAS SCHOOL OF MINES AND METALLURGY—This school has figured in recent newspaper reports from Kansas as the "smallest college in the country, having three students and three professors." These reports evidently were based on the enrollment at the belated opening of the institution (Oct. 10, 1912), for the number of students increased to 17 in January and the prospects are for an enrollment of 30 at the beginning of the second term.

In 1911 the Kansas Legislature created this school and established it at the town of Weir in Cherokee County, naming as its principal purpose

> the teaching of such branches in mining and metallurgy as will give a fair technical knowledge of mines and mining, and all subjects pertaining thereto, including physics in mining, engineering, mathematics, chemistry, geology, mineralogy, metallurgy, shop work, drawing, the technical knowledge and properties of mine gases, assaying, surveying, drafting of maps and plans, and such other subjects pertaining to mining engineering as may add to the safety and economical operation of mines within this state.

The school was created as an independent institution, but under the supervision and control of the Board of Regents of the State University. The Regents agreed not to open the school, believing that it would interfere with the work of the State University, and that the State Legislature had passed the bill under a misapprehension. However, the Board was compelled to proceed with the project under a mandamus suit. The act of the Legislature was construed by the Supreme Court as demanding a separate and independent institution of higher learning. It is reported that there is an appreciable and growing sentiment for this school and that a distinct and useful field of service is opening up.

The Director, Burton L. Wolfe, has asked the Legislature, through the Regents, for an appropriation of $111,361; of this, $75,000 is for a modern three-story main building, 60x120 ft.; $9826 is for added equipment, and $26,535 is for maintenance during the year 1913-1914. A further request for $93,120 is made for the year 1914-1915; of this, $33,750 is for a two-story building to house a power plant, machine shops and ore-dressing and metallurgical laboratories; $13,000 is for the equipment of this building, and $46,370 for maintenance. Citizens of Weir have offered as a site a square tract of 21 acres.

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While Thawing Out Dynamite for use on a sewer laying job in Montreal, Canada, on Feb. 24, one man was killed and another badly injured by a premature explosion.

Levee Work Is Held Up by High Water in the Mississippi River below the mouth of the Red River, according to information from Frank M. Kerr, of the Louisiana Board of State Engineers.

Concrete Laying on the Panama canal locks is near completion. On Feb. 15, the "Canal Record" states that over 97% of the concrete work in the locks had been placed, the total amount of concrete laid being 4,306,209 cu.yd.

Paris to London by Aëroplane in 6½ hr. flying time, is the feat performed by a French aviator, on Feb. 25. The trip was made with but one stop, at Calais. The channel crossing, reckoned dangerous by aviators in the best weather, was made in a fog.

The Engineering Societies Building, at 29 West 39th St., New York City, is now the headquarters of 41 different engineering societies, which either have permanent offices in the building or hold their meetings in some of its rooms or in the main auditorium.

An Advisory Good Roads Commission has been appointed by Gov. Sulzer, of New York, to confer with the governor and to advise him regarding the best way to carry out the provisions of the proposed new highway bill for the State. The commission consists of some 18 members and has in its personnel a curious mixture of machine politicians and competent engineers.

Three Safety Medals in memory of the late E. H. Harriman, have been placed at the disposal of the American Museum of Safety by Mrs. Harriman. These will be awarded annually, the first to the railroad which makes the greatest progress in accident prevention. The second, to the operation head who is judged to have done the most to promote safety during the preceding year. A third medal, of bronze, will be awarded to the employee is judged to have rendered the most conspicuous service in preventing accidents.

Concrete Pile Regulations are the subject of study by the Bureau of Buildings of the Borough of Manhattan, New York City. Rudolph P. Miller, Superintendent, has issued a note reading as follows:

> The Superintendent of Buildings of the Borough of Manhattan wishes to inform the public that he has under preparation regulations governing concrete piles. He would be glad to have any suggestions or criticisms from those interested, and will send on request a copy of the tentative draft now prepared.

Blasting Operations at Gijon, Spain, undertaken for the purpose of leveling a hill between that place and the coast town of Musel, resulted on Feb. 25, in the death of about 30 persons and injuries to a large number of others. A charge of 7000 lb. of black powder had been placed and the populace had gathered to watch the effect of the explosion. When the charge was fired, instead of effecting the desired breakage of rock, according to press accounts, it projected a quantity of small stones into the crowd.

Questions of Policy affecting both the electric-light and electric-railroad industries are to be handled hereafter by a joint committee representing the American Electric Railway Association and the National Electrical Light Association; there being two appointed from each. This is the result of a joint dinner for the discussion of mutual problems held in New York City, Feb. 18. Among the topics which the committee proposes to take up at once are questions of welfare work, service annuities, minimum wages and education of employees.

An Invitation for American Bids "for the construction of a complete refrigerating plant for the cold-storage premises of the wholesale meat market of the Moscow abattoirs" is the latest tribute to American engineering skill, as recently recorded in the New York "Herald." It appears that bids had been invited previously for the same work, but with results unsatisfactory to the authorities concerned, so it was decided by them to extend the time limit from Jan. 28 to May 8 and advertise for American bids.

A feature worthy of note is that the Moscow abattoirs are under the control of the municipal administration, which is charged with the construction and maintenance of all buildings in connection with the same.

The Necaxa Power-plant Extension in Mexico is progressing favorably in spite of the political disturbances. Work is expected to be completed in a few months. This extension of the well known Necaxa hydraulic power station involves increase of the water supply by a collecting conduit which taps a number of minor drainage areas. Much of this conduit is in tunnel. Extensive and difficult tunneling work in soft ground has been required, particularly at the lowest or downstream tunnel of the group, this being also the longest tunnel. Much caving ground and heavy water flow here have been responsible for much delay. At the present time, even under the unfavorable conditions, with the working face about a mile from the portal, a progress of 65 to 80 ft. per

month is being recorded. The tunneling work is being handled for F. S. Pearson by Jacobs & Davies, of New York City.

The Atherton Ave. 170-ft. Concrete Arch Bridge, in Pittsburgh, Penn., crossing Junction Hollow and the tracks of the Pittsburgh Junction Ry., was opened for traffic Feb. 19, 1913. The bridge was described and illustrated in our issue of Dec. 19, 1912. It provides a much-needed additional route from the business district to the East End residence territory, providing for street traffic, which is now compelled to concentrate on a street encumbered by street-railway tracks. The Atherton Ave. improvement comprises, besides the above-mentioned bridge, a three-span concrete-arch bridge over the Pennsylvania R.R., widening of the street to 60 ft. in a section which is now narrower, and a small amount of grade reduction. The Pennsylvania R.R. bridge is completed so far as the structure is concerned, but its paved roadway will not be ready until spring.

Two Freak Accidents were noted in a recent issue of the "Travelers Standard," from which the following accounts are taken:

A freight train on the Memphis branch of the Louisville & Nashville R.R. recently collided with the packet-boat "Lochie S.," at Cumberland City, Tenn. This peculiar accident was made possible by a flood in the Cumberland River. The water stood over the Louisville & Nashville tracks at several places, and the "Lochie S.," which is a light-draught boat, was steaming directly over the railroad's right-of-way, doubtless with no suspicion of this fact in the pilot's mind. The night was dark, and as the engineer on the train did not see the boat and did not understand steamboat signals, he was very close to her before he knew it. The emergency brakes were applied, but not soon enough to avoid a collision. Nobody was injured, and no harm was done to the locomotive or the train. The packet was damaged somewhat, however. According to newspaper reports, the owners of the boat claim that their craft was not trespassing in proceeding anywhere upon the waters of a navigable stream, and the railroad sets up the counter claim that it was within its rights so long as the train remained upon the company's tracks. Railroad men and river men agree that the accident is one of the most remarkable on record, and there have been many interesting discussions as to the responsibility for the damage.

While carrying a steel plate across the mill yard at the Ambridge plant of the American Bridge Company, a workman recently came within the influence of a powerful electromagnet that was unloading scrap iron from a freight car. The magnet suddenly pulled up the plate of steel that he had on his shoulders, and as he held tightly to it he was drawn up also. He cried out when his feet left the ground, and the man controlling the magnet shut off the current. The plate then dropped, and in doing so it fell upon the man and crushed him so badly that he died shortly afterward.

A River Regulation Commission was provided for by a Senate amendment to the River and Harbor appropriation bill, adopted by the Senate on Feb. 25. The amendment is understood to be the work of Senator Newlands, of Nevada. An amendment is also made to the same bill requiring the Board of Engineers for Rivers and Harbors to make a preliminary report to Congress before Dec. 1, 1913, on a general plan of improvement for all the waterways of the country. Both provisions were killed in conference, and were not made a part of the River and Harbor bill. The two clauses referred to are as follows:

That the Secretary of War shall cause the Chief of Engineers of the Army and the Board of Engineers for Rivers and Harbors to report to Congress, in which shall be included a preliminary report not later than Dec. 1, 1913, upon the saving, as well as other advantages, which can be accomplished by the adoption of the continuing contract system, the rapidity with which projects should be completed, upon methods of standardization by which the waterways of the country may be improved uniformly in proportion to their capacities and to the existing or probable demands of general commerce, and also report upon one or more systematized schemes of such improvement, involving all waterways heretofore examined, together with any natural or artificial channels, essential for the utilization thereof, whether heretofore examined or not; also upon all projects heretofore adopted, the further improvement of which is not desirable or the expenditure upon which is out of proportion to the benefit derived therefrom. Such report may include other related information pertaining to the uses or control of the waters of the country, and the sum of $100,000 or so much thereof as may be necessary, is hereby appropriated for such examination and report.

A commission, to be known as the River Regulation Commission, consisting of the Secretary of War, the Secretary of the Interior, the Secretary of Agriculture, the Secretary of Commerce and Labor, two Members of the Senate, to be selected by the President of the Senate, and two Members of the House of Representatives, to be selected by the Speaker, is hereby created and authorized to bring into coördination and coöperation with the Corps of Engineers of the Army the other scientific or constructive services of the United States that relate to the study, development, and control of waterways and water resources and subjects related thereto, and to the development and regulation of interstate and foreign commerce, with a view to uniting such services through a board or boards in investigating questions relating to the development, improvement, regulation, and control of navigation as a part of interstate and foreign commerce, including therein the related questions of irrigation, forestry, swamp-land reclamation, clarification of streams, regulation of flow, control of floods, utilization of water power, prevention of soil waste, coöperation of railways and waterways, and promotion of transfer facilities and sites, and in forming comprehensive plans for the development of the waterways and water resources of the country for every useful purpose by coöperation between the United States and the several States, municipalities, communities, corporations, and individuals within the jurisdiction, powers, and rights of each, respectively, and with a view to assigning to the United States such portion of such development, promotion, regulation, and control as can be properly undertaken by the United States by virtue of its power to regulate interstate and foreign commerce and by reason of its proprietary interest in the public domain, and to the States, municipalities, communities, corporations, and individuals such portion as properly belongs to their jurisdiction, rights and interests, and with a view to properly apportioning costs and benefits, and with a view to so uniting the plans and works of the United States within its jurisdiction, and of the States and municipalities, respectively, within their jurisdictions, and of corporations, communities, and individuals within their respective power and rights, as to secure the highest development and utilization of the waterways and water resources of the United States; and such River Regulation Commission is authorized to appoint as members of such board or boards such engineers, transportation experts, experts in water development, and constructors of eminence as it may deem advisable to employ in connection with such plans. And for the expenses of such organization, investigation, and plans the sum of $500,000 is hereby appropriated.

PERSONALS

Mr. D. S. Terry has been appointed Construction Engineer at Cincinnati, Ohio, of the Cleveland, Cincinnati, Chicago & St. Louis Ry., succeeding Mr. F. W. Smith.

Mr. D. Gilmour has been appointed Superintendent of the Montreal, Que., terminals of the Grand Trunk Ry., succeeding Mr. R. W. Scott, relieved on account of ill health.

Mr. A. S. Proudfoot, formerly with the Suburban Engineering Co., New York City, has been appointed Assistant to the Contract Manager of the Turner Construction Co., New York City.

Mr. Burton E. Reed, for a number of years with the Vandalia R.R., has been appointed Assistant to the General Manager of the International Interlocking Rail Joint Manufacturing Co., Chicago, Ill.

Mr. Hans Helland, Superintendent of Maintenance-of-way of the San Antonio & Aransas Pass Ry., at Yoakum, Tex., has been promoted to be Construction Engineer, with headquarters at San Antonio, Tex.

Prof. Frank B. Cooper, of the Randolph Macon College, Virginia, has been appointed Professor of physics at the Stevens Institute of Technology, succeeding Prof. Roger H. Galt, resigned on account of ill health.

Mr. R. B. Titsworth, Assoc. M. Am. Soc. C. E., Contracting Engineer of the McClintic-Marshall Construction Co., Pittsburgh, Penn., has resigned to become associated with the Detroit Bridge & Steel Works, Detroit, Mich.

Mr. Isham Randolph, M. Am. Soc. C. E., Consulting Engineer, of Chicago, Ill., has been awarded an Elliott Cresson Gold Medal of the Franklin Institute, of Philadelphia, "for distinguished achievements in the field of civil engineering."

Mr. A. W. Stephens, Assoc. M. Am. Soc. C. E., formerly Designing Engineer of the Turner Construction Co., New York City, has been promoted to be Engineer of the company. Mr. Stephens has been with the company for nearly eight years.

Mr. C. H. Harlan, Designing Engineer of the McClintic-Marshall Construction Co., Pittsburgh, Penn., has been promoted to be Contracting Engineer, succeeding Mr. R. B. Titsworth, Assoc. M. Am. Soc. C. E., resigned, as noted elsewhere.

Mr. Walter H. Lienesch, formerly connected with the Illinois Traction System, has been appointed Consulting Engineer in charge of the engineering department of the International Interlocking Rail Joint Manufacturing Co., of Chicago, Ill.

Mr. William W. Bosworth, M. Am. Inst. Arch., of New York City, has been chosen as the Architect for the new buildings of the Massachusetts Institute of Technology to be erected in Cambridge, Mass. Mr. Bosworth was a student at the Institute in 1886-1888.

Mr. R. E. Harrison, Assoc. M. Am. Soc. C. E., recently Resident Engineer in charge of the construction of the water filtration plant of the Grand Rapids, Mich., water-works, has resigned to accept the position of Supervising Engineer of construction for the Roberts Filter Manufacturing Co., of Darby, Penn.

Mr. M. C. Byers, M. Am. Soc. C. E., Chief Engineer of Operation of the St. Louis & San Francisco R.R., has resigned and the office has been abolished. Mr. Byers has been appointed Assistant to the President of the Great Northern

Ry., at St. Paul, Minn., succeeding Mr. Ralph Budd, M. Am. Soc. C. E., promoted, as noted in our issue of last week.

Mr. Charles P. Steinmetz, Past-President, Am. Inst. E. E., Consulting Engineer of the General Electric Co., Schenectady, N. Y., has been awarded an Elliott Cresson Gold Medal of the Franklin Institute, of Philadelphia, "for successful application of analytical methods to the solution of problems of the first practical importance in the field of electrical engineering."

Mr. Herman W. Hoefer has resigned as State Architect of New York with charges of alleged incompetency and inefficiency pending against him. Mr. Hoefer was appointed by Governor Dix in April of last year and reappointed by Governor Sulzer. He was formerly an architect of New York City. Deputy Architect Charles A. Susdorf has been appointed Acting State Architect.

Mr. William T. Blunt, M. Am. Soc. C. E., for many years United States Assistant Engineer on harbor improvement work at the west end of Lake Erie, and more recently Superintendent of subaqueous rock excavation, Panama Canal, has become associated with the Shirley-Skeldon Dredging & Submarine Contracting Co., Toledo, Ohio, as Secretary-Treasurer and Consulting Engineer.

Mr. R. C. Wilson, recently Superintendent in charge of construction work for the Turner Construction Co., New York City, has been appointed Engineer in charge of the department of designs of the company. Mr. Wilson has been with the Turner Construction Co. for the past six years and has had charge of erection on some of the company's most important building contracts.

Mr. Robert M. Anderson, M. Am. Soc. M. E., has joined the faculty of the Stevens Institute of Technology as Instructor in engineering practice. Mr. Anderson graduated from Stevens Institute of Technology in 1887 and was a member of the faculty for several years, first as Assistant in the department of mathematics and later in the department of experimental engineering.

Mr. A. C. Tozzer, Assoc. M. Am. Soc. C. E., formerly Superintendent in charge of construction for the Turner Construction Co., New York City, has been appointed General Superintendent for the New York City district of the company. Mr. Tozzer has been with the company eight years and was recently in charge of construction of the Bush Terminal Co. model loft buildings in South Brooklyn, N. Y.

Mr. George McCormick, formerly Assistant Superintendent of the Galveston, Harrisburg & San Antonio Ry., at El Paso, Tex., has been promoted to be Assistant General Manager, mechanical department, at Houston, Tex., succeeding Mr. J. W. Small, resigned. Mr. McCormick also becomes Superintendent of motive power and machinery of Morgan's Louisiana & Texas R.R. & Steamship Co. and the Louisiana & Western R.R., other subsidiaries of the Southern Pacific Ry.

Mr. H. W. Ridgway, recently Master Mechanic of the Colorado & Southern R.R. and the Atchison, Topeka & Santa Fé Ry. at Denver, Colo., has been promoted to be Superintendent of the motive power and car departments of the Colorado & Southern R.R., at Denver. Mr. Ridgway began his railway experience as a machinist apprentice with the Denver & Rio Grande R.R. in 1881. For many years he was employed by the Mexican Central Ry., first as journeyman and foreman and later as Superintendent of Shops at Aguascalientes.

Mr. Charles J. Bennett, of Hartford, Conn., on Feb. 25, took office as State Highway Commissioner of Connecticut, following his appointment by Gov. Baldwin and confirmation by the State Senate. Gov. Baldwin, at the beginning of his first term, two years ago, appointed a successor to Commissioner James H. MacDonald, who has held the office for a number of years, but his appointee failed of confirmation. In January of this year, at the beginning of his second term, Gov. Baldwin again appointed a successor to Mr. MacDonald, but the Senate refused again to confirm. The Governor thereupon appointed Mr. Bennett, with the result noted above.

Mr. J. R. Wood, Passenger Traffic Manager of the Pennsylvania R.R., has retired under the company's pension rules, having reached the age of 70 years on Feb. 9. Mr. Wood's railway career began in 1869, at the age of 26, as Secretary to the Superintendent of the Burlington & Missouri River R.R., at Creston, Iowa. Later he was Trainmaster and General Western Passenger Agent of the same railway at Chicago, Ill. Afterward he served in the passenger traffic and operating departments of the Michigan Central R.R. and the Chicago, Burlington & Quincy R.R. His connection with the Pennsylvania R.R. began in 1881 as General Passenger Agent. In 1903 he was appointed Passenger Traffic Manager.

Mr. F. G. Jonah, M. Am. Soc. C. E., Chief Engineer of Construction of the St. Louis & San Francisco R.R. and Chief Engineer of the New Orleans, Texas & Mexico and the St. Louis, Brownsville & Mexico Rys., has been promoted to be Chief Engineer of all these lines, and the office of Chief Engineer of Construction has been abolished. Mr. Jonah is a Canadian by birth. After a high-school education he entered the office of the Chief Engineer of the Intercolonial Ry. as a student in 1882, at 18 years of age. He remained here for five years, serving as chainman, rodman, leveler and transitman. In 1887 he was appointed Resident Engineer on construction of the Oxford & New Glasgow Ry., but two years later returned to the Intercolonial Ry. as Assistant Engineer. Mr. Jonah came to the United States in 1890 to accept a position as Assistant Engineer of the St. Louis Merchants' Bridge Terminal Ry. For five years, 1894 to 1899, he was Resident Engineer of the St. Louis, Peoria & Northern Ry., which position he resigned to become Engineer of Maintenance-of-way of the Chicago & Alton Ry. In 1901 he was appointed Chief Engineer of the Blackwell Enid & Southwestern Ry. His connection with the St. Louis & San Francisco R.R. began ten years ago when he was appointed Assistant Engineer.

Messrs. Samuel C. McMeen and Kempster B. Miller, M's. Am. Inst. E. E., announce the incorporation of the firm of McMeen & Miller, Engineers, 1454 Monadnock Block, Chicago, Ill. The personnel of the firm includes besides the former partners, Mr. Leigh S. Keith Assoc. Am. Inst. E. E., who has been connected with the firm for a number of years as Managing Engineer. Mr. McMeen is senior member and Vice-President of the new firm and is well known as a telephone engineer. His experience with the Central Union Telephone Co., of Chicago, covered various positions from operator to Chief Engineer. Before entering partnership with Mr. Miller he was connected with the Western Electric Co. Mr. Miller is President of the new firm, and is widely known among electrical engineers as the author of "American Telephone Practice." He is a graduate of Cornell University. For many years he was connected with the Kellogg Switchboard & Supply Co., in Chicago, as Engineer and Manager. Mr. Keith, who is the Secretary-Treasurer of the firm, graduated from the Massachusetts Institute of Technology in 1900. He was employed for a number of years in the engineering department of the New York Telephone Co. He entered the employ of McMeen & Miller about four years ago, and for the past three years has been Managing Engineer of the firm. The organization of the firm has been increased to include a sufficient corps of engineers to handle all branches of electrical engineering practice.

Among some 30-odd men to be dined and publicly honored by the City Club of New York, on Mar. 10, for honorable and efficient service rendered to New York City, and each of whose services covers a period of at least five years, are found a goodly representation of engineers and public health officials. In speaking of the action of the City Club, which is an organization of 1300 members and founded in the interest of good municipal government, the New York "Times" of Mar. 2, rightly says, "The bright light of publicity which shines and must shine on the administrative heads of the huge offices that do the municipal business of New York often leaves in the shadow and in half-shadow men who in less conspicuous posts labor year in and year out with unflagging devotion for the city's good." According to the "Times," among the guests included are:

Mr. Nelson P. Lewis, M. Am. Soc. C. E., has been Chief Engineer of three successive Boards of Estimate and Apportionment. As such, he has been distinguished by the honesty and accuracy of his reports and investigations, and by a continuously intelligent interest in the physical development of the city. . . . . Week after week the public improvement calendar is referred to Mr. Lewis for scientific and disinterested service, which has been the mainstay of several administrations.

Mr. Harry P. Nichols has been Chief of the Bureau of Franchises since it was established. To him have been referred week after week all requests for grants of franchises by the Board of Estimate. He is largely responsible for the development of a uniform franchise policy by the city. At the time Mr. Nichols started his service, there was neither rhyme nor reason in the treatment of franchises by the Board of Estimate. Since that time the standardization of franchise granting has become a topic of nation-wide discussion.

Dr. Ernst J. Lederle, Health Commissioner, is an example of the increasing number of commissioners drawn from the city's permanent civil service. Dr. Lederle was an employee of the Health Department for over 20 years, before his opportunity came in 1902 to reorganize the department. His services to public health have been very great.

Dr. Walter Bensel has been Sanitary Superintendent for two successive administrations of the Health Department. Citizens of New York will not soon forget the energetic and efficient manner in which he exercised the summary powers of the department during the street-cleaning strike a few years ago. He is the energizing force in the field work of the city's health service.

Mr. J. Waldo Smith, M. Am. Soc. C. E., has been Chief Engineer of the Board of Water Supply, which started the plan and construction of the Catskill system. The board was endowed with unusually broad powers of discretion, the exercise of which brought upon it much criticism in the Ashokan Dam and other matters. The failure in other work of the contractors whose bids were rejected has since demonstrated the wisdom of the board's course, for which Mr. Smith was largely responsible. The rapidity with which the Catskill work has been carried on marks it as one of the greatest municipal engineering achievements in the United States.

Dr. Daniel D. Jackson: Over in the quiet of a little building at the Prospect Park Reservoir there are arranged daily before Dr. Jackson samples taken from each and every source of New York City's water supply. He is, therefore, the sentinel of public health. Every source showing the slighest trace of infection is immediately closed and antiseptically treated. His work has undoubtedly saved thousands of lives every year.

Messrs. Benjamin F. Welton and Otto H. Klein are engineers in the office of the Commissioner of Accounts. They have not only constantly given expert advice in the various investigations conducted by the Commissioners of Accounts, but they have been faithful students of New York's municipal problems—men whose coöperation and assistance have been invaluable in many other parts of the city government.

Mr. George W. Tillson, M. Am. Soc. C. E., an engineer in the office of the Brooklyn Borough President, is a long-time public servant whose advice and work on street pavements has been of particular value to the city.

Mr. M. L. Fouquet, an engineer of the Brooklyn Borough President's office, has made a specialty of the problems, both engineering and otherwise, connected with the subsurface use of the city's streets. He has not only established a definite department for dealing with subsurface work in the Borough of Brooklyn, but has assisted in the formation of similar, necessary divisions in the offices of other Borough Presidents.

Mr. John T. Featherston: His work, both experimental and practical, in the disposition of refuse on Staten Island, has marked him as one of the chief authorities on this subject in the United States. Some time ago the city of Chicago unsuccessfully sought to take him away from us.

Gen. Theodore A. Bingham: It is not given to all of us to be as versatile as Gen. Bingham, who not only put the fear of God into the police force for several years, but who seems able to do the same thing to contractors. He also wisely plans and advises in the engineering work of the Department of Bridges.

Dr. John S. Billings: Probably no official in the city's service has had a more versatile and interesting career than Dr. Billings. Brevetted for faithful and meritorious service during the civil war he spent many years in the medical service of the United States Army; he prepared the vital statistics of both the 10th and 11th censuses; was Professor of Hygiene in the University of Pennsylvania, and in 1896 decided to spend the rest of his life in the service of the City of New York as Director of its great public library system.

OBITUARY

Lucien M. Cunningham, a civil engineer of Denver, Colo., died in that city, Feb. 21. He had not been in active practice for several years on account of ill health.

John R. Price, a railway contractor in the early days of the Atchison, Topeka & Santa Fé Ry. and pioneer Mexican railways, died at his home in Turon, Kan., Feb. 24. He was 84 years old.

A. O. Graydon, former City Engineer of London, Ont., died at the Victoria Hospital in that city on Feb. 28. He was born in Canada in 1852. He entered the city engineering department of London as a young man and in 1891 succeeded to the office of City Engineer, which he held for nearly 20 years.

Max Boehmer, M. Am. Inst. M. E., a civil and mining engineer of Denver, Colo., died at his home in that city Feb. 14, aged 66 years. He was a native of Germany and received his technical education in that country. He came to America as a young man and was first engaged in civil-engineering work on the improvement of the Mississippi and Missouri Rivers. He went to Colorado in 1879 and for many years was Consulting Engineer for several large mining interests.

Dr. Philip Hanson Hiss, Jr., Professor of bateriology at Columbia University, died Feb. 27. He was born in Baltimore, Md., in 1868 and graduated from Johns Hopkins University in 1891; he received his degree of Doctor of Medicine at Columbia University in 1895. He was Assistant Bacteriologist of the Department of Health of New York City from 1896 to 1899. He was famous among sanitarians for his work in isolating typhoid bacilli, and his studies of the bacteriology of typhoid fever.

Robert B. Seymour, former Chief Engineer of the Chicago, Indiana & Southern R.R., died at his home at Oak Park, Ill., Feb. 23. Mr. Seymour was born at Hingham, Mass., in 1859. His engineering experience began at the age of 22 years. In 1885 he entered the engineering corps of the Illinois Central R.R., at Chicago. Later he was connected with the building of the Richmond, Petersburg & Carolina R.R., now a part of the Seaboard Air Line Ry. He was afterward Chief Engineer of the Chicago, Indiana & Southern R.R. until its absorption by the New York Central Lines, when he entered private practice as a consulting engineer.

Charles E. Gossett, General Master Mechanic of the Minneapolis & St. Louis R.R., at Minneapolis, Minn., died at his home in Rochester, Minn., Feb. 19. He was 44 years old. He was educated at the Missouri State University and entered the railway service in 1886 as a machinist helper with the Wabash, St. Louis & Pacific R.R. Later he was fireman and locomotive engineer on various railways in the Middle West. In 1905 he was promoted to be road foreman of engines of the Chicago, Rock Island & Pacific Ry. and shortly afterward Master Mechanic. Three years later he was appointed Master Mechanic of the Iowa Central R.R. and in 1910 accepted the same office with the Minneapolis & St. Louis R.R. He was promoted to General Master Mechanic on Jan. 1, 1912.

Robert Law, former Vice-President and General Manager of the Colorado & Northwestern R.R., died recently at Los Angeles, Calif. He was born in New York State in 1851. After a common school education he entered the railway service at 10 years of age, in 1861, as a water boy on the Atlantic & Great Western Ry. From 1866 to 1882 he was with the Union Pacific R.R. as foreman on trackwork and construction, Division Roadmaster, General Roadmaster, Division Superintendent, Superintendent of Construction and General Superintendent. From 1882 to 1886 he was General Superintendent of the Missouri lines of the Burlington System. From 1886 to 1890 he was Division Superintendent and Assistant General Manager of the Northern Pacific Ry. For a few years following he was Manager of the Chicago Ry. Transfer Association. In 1893 he became Manager of the Burlington & Northwestern Ry. at Burlington, Iowa. His last active work in railroading was with the Colorado & Northwestern R.R.

Sir William Henry White, Past-President of the Institution of Civil Engineers of Great Britain, and the most eminent naval engineer of his time, suffered a stroke of apoplexy on Feb. 27 and his death shortly ensued.

William White was born in the dockyard town of Devenport, England, Feb. 2, 1845. The illness of his father placed the family in straitened circumstances, and at the age of 14 William White entered the Government dockyard as an ordinary shipwright apprentice boy. He had neither means nor influence back of him, so his chances for rising above the grade of an ordinary workman were apparently no better than those of any other of the many apprentices in the yard. There was, however, a system of examinations for apprentices desirous of proving their ability and industry and William White's record in these examinations was so excellent that it won for him admission to the Royal School of Naval Architecture. He achieved high honors here and received a diploma as Fellow in the first class.

Upon his graduation he was appointed a member of the staff of the Chief Naval Constructor at Whitehall and at the early age of 22 was made confidential assistant to Sir Edward Reed of the Admiralty. For fourteen years he worked steadily in the Government service, and in 1881, when only 36 years of age, he was made Chief Constructor, the highest rank in the corps of Royal Naval Constructors.

In 1883, at the solicitation of the great engineering firm of Armstrong & Co., at Newcastle, he resigned from the Navy and assumed chief responsibility for the great Armstrong shipbuilding plant. During the two years from 1883 to 1885 while Mr. White remained with the Armstrong firm he designed and superintended the building of ships for China, Japan, Italy and Spain. At this time the United States was just setting about the preliminary steps toward creating a modern navy, and some of the designs for its first vessels were purchased from the Armstrong firm, having been made under Sir William White's direction.

In 1885, Sir Nathaniel Barnaby, who had succeeded Sir William White as Chief Constructor of the British Navy, became ill. The Government was about to undertake an enormous increase in the naval establishment far beyond anything before dreamed of. It was deemed necessary to have the most competent ship designer obtainable at the head of its work. Lord George Hamilton, First Lord of the Admiralty, asked William White to return to the Government service and take the chief responsibility for the design of this new British navy.

From the pecuniary point of view the acceptance of the Government offer meant a sacrifice, for in Great Britain as in the United States the Government pays meager salaries to men of high ability compared with what they could command in private business. The appeal was made, however, to William White's patriotism, and was not made in vain.